Volume 22, Number 12, June 30, 1968

NUCLEAR SCIENCE ABSTRACTS

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Index References

All index entries refer the reader to volume and abstract number:

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FOURRIER, Alain
  Radioactive chain of mass number 189,  21:10023
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Personal Authors

Every author's name is indexed in the form appearing on the document abstracted:

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MONTH, M.
  Theory of gradient perturbations in AGS,  21:9872 (BNL-
    10899)
MONTH, Melvin
  Simple relativistic calculation of the electromagnetic
    form factors of the deuteron,  21:9744
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Subjects

The subject index consisting of specific materials, objects, and processes is arranged alphabetically. Modifying phrases specific to these subjects in turn are arranged alphabetically under the subjects.

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SHEEP
  radiation dosimetry in, measurement of lethal dose of x,
    21:8905(R) (AD-631189)
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    21:8905(R) (AD-631189)
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    21:8779(R) (AD-629928)
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    21:8782(R) (AD-631424)
  evaluation of fallout, for fire and air blast damage,
    21:8560 (URS-658-3)
  fire resistance of components of, evaluation of,
    21:8789(R) (AD-642241)
```

Corporate Authors

Technical report literature is indexed from the name of the organization or institution responsible for the issuance of the report.

8500 (Y-1561) MIXING AND SAMPLING ENRICHED ^{235}U FLUIDS IN CYLINDRICAL STORAGE CONTAINERS. Final Report. Harrell, J. E. **(Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant).** Jan. 17, 1967. Contract W-7405-eng-26. 124p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

is indexed as:

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UNION CARBIDE CORP., OAK RIDGE, TENN.  Y-12 PLANT.
  Mixing and sampling enriched 235U fluids in cylindrical
    storage containers,  21:8500 (Y-1561)
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Report Numbers

Technical report literature is also indexed by report numbers. This index includes information on where individual reports may be obtained. While not reports, patents and conference papers are indexed here as a matter of convenience.

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TID-
  3311(Suppl. 2)  21-8567   Dep. mn. CFSTI $3.00 cy, $0.65 mn
  22298           21-9915   Nucl. News, 9: No. 12, 17-21 (Dec.
                              1966)
  22298           21-9914   Nucl. News, 10: No. 1, 17-20(Jan.
                              1967)
  23267           21-9702   Phys. Rev., 152: 1171-82(Dec. 23,
                              1966)
  23287           21-8498   Dep. mn. CFSTI $3.00 cy, $0.65 mn
  23420           21-8764   Lancet, 2: 672-5(Sept. 24, 1966)
  23474           21-8528   Dep. mn. CFSTI $3.00 cy, $0.65 mn
  23478           21-8641   Dep. mn. CFSTI $3.00 cy, $0.65 mn
  23482           21-9471   Dep. mn. CFSTI $3.00 cy, $0.65 mn
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NUCLEAR SCIENCE ABSTRACTS

CHEMISTRY

Analytical Chemistry

Refer also to abstracts 23003, 23086, 23114, 23137, 23180, 23245, 23342, 23593, 24788, 24855, and 25215.

22926 (BARC-312) SPECTROGRAPHIC DETERMINATION OF ALLOYING ELEMENTS IN ZIRCALOYS. Krishnan, T. S.; Dhall, Premkumar; Pathare, K. R. (Bhabha Atomic Research Centre, Bombay (India)). 1967. 7p. Dep.

A spectrographic method has been developed for the determination of alloying elements in zircaloys in the following concentration ranges: chromium and iron 0.025 to 0.2%; nickel 0.0125 to 0.1%; and tin 0.25 to 2%. The sample in the form of oxide is mixed with zinc oxide and graphite in equal proportions and 10 mg of this mixture is burnt in a direct current arc of 10 A. Using cobalt as the internal standard, the standard deviations calculated from spectra taken on different plates on different days range between ±3 to 6% for the different elements. (auth)

22927 (BNWL-690) SURVEY OF METHODS USED AT U. S. LABORATORIES TO MEASURE IMPURITIES IN SODIUM. Demmitt, T. F. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Feb. 1968. Contract AT(45-1)-1830. 12p. Dep. CFSTI.

A survey was conducted to determine the manual analytical procedures used routinely to measure oxygen, carbon, hydrogen, nitrogen, and trace metal impurities in sodium. All of the major U. S. laboratories that either are or recently have been engaged in sodium analytical chemistry studies were surveyed. The results of the survey are presented. No attempt is made to include specific information concerning analysis methods for other impurities, e.g., fission products, particulates, etc. (auth)

22928 (CONF-670502-, pp 343-54) AUGMENTING THE SEPARATION OF GADOLINIUM AND EUROPIUM AND EUROPIUM AND SAMARIUM MIXTURES IN ION EXCHANGE ELUTIONS WITH EDTA. Powell, J. E.; Burkholder, H. R. (Iowa State Univ. of Science and Technology, Ames).

Scrutiny of thermodynamic data and proposed models for hydrated ethylenediaminetetraacetato chelates of the rare earths suggested a means of improving displacement chromatographic separations of Gd-Eu and Eu-Sm mixtures on cation exchange columns. Increasing the operating temperature from 25 to 92°C effected an increase in the Gd-Eu separation factor from a skimpy 1.1 to a robust 1.47 ± 0.07 and the Eu-Sm separation factor from 1.4 to 1.8, presumably by destroying a degree of internal hydrogen bonding, which occurs to a varying extent in the case of the less-constrained lighter rare earth EDTA chelates at room temperature. Apparently this type of internal hydrogen bonding is not possible in the case of smaller heavier rare earth EDTA chelates (Gd through Lu). (auth)

22929 (GA-8013) APPLICATIONS OF NEUTRON ACTIVATION ANALYSIS IN SCIENTIFIC CRIME DETECTION. 10-Month Summary Report: January 1-October 31, 1966. Guinn, V. P. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). Oct. 20, 1967. Contract AT(04-3)-167. 62p. Dep. CFSTI.

In extensions of previous work, studies were made on paints, gunshot residues, glass, and paper. Exploratory studies were conducted on neutron activation analysis of evidence-type materials and on printing inks, microscope mounting media (used for examination of hair specimens), and plastic sheeting suitable for the collection of bomb-detonation residues in test explosions. In addition, studies were performed to investigate the use of high-resolution Ge(Li) semiconductor detectors in gamma spectrometry of neutron- and photon-activated samples of some materials of forensic interest. (M.C.G.)

22930 (NBL-242) ANNUAL PROGRESS REPORT FOR THE PERIOD JULY 1966-JUNE 1967. (New Brunswick Lab. (AEC), N. J.). Mar. 1968. 78p. Dep. CFSTI.

Research progress is reported on halogen determination in boron, determination of boron in stainless steel-boron systems, x-ray spectrographic determination of impurities in boron, spectrochemical determination of tantalum and tungsten in boron, determination of oxygen and nitrogen by inert-gas fusion, spectrophotometric determination of cobalt, spectrophotometric determination of aluminum in beryllium, dissolution of UO_2-ZrO_2-CaO wafer fuel, dissolution of niobium-coated UC-graphite fuel, storage of stabilized plutonium nitrate solutions in sealed ampoules, preliminary evaluation of method for spectrographic determination of impurities in U-Pu-Mo solutions, fusion of refractory PuO_2-UO_2 and subsequent plutonium recovery, determination of rare earths in thorium oxide samples, determination of impurities in materials by spark-source mass spectrography, solid-state controlled-potential coulometers, and a darkroom timer. (M.C.G.)

22931 (NBL-243) OPERATING PRACTICES USED IN PLUTONIUM ANALYTICAL LABORATORIES. Rodden, C. J. (New Brunswick Lab. (AEC), N. J.). Apr. 1968. 23p. Dep. CFSTI.

A compilation of the replies to a questionnaire concerning plutonium containment sent to eighteen analytical laboratories in the United States is presented.

22932 (NP-17233) DETERMINATION OF CONCENTRATIONS OF URANIUM AND PLUTONIUM BY ISOTOPIC DILUTION MASS SPECTROMETRY. Bokelund, H. (European Company for the Chemical Processing of Irradiated Fuels, Mol (Belgium)). Sept. 1967. 35p. (ETR-217). Dep.

The isotropic dilution mass-spectrometric method was employed to determine the concentrations of uranium and plutonium in dissolver solutions. Calibration of the spike solutions, i.e., ^{233}U and ^{242}Pu, is described along with the analytical techniques used to prepare the samples for mass assay. Results on actual plant samples are given and the overall precision, based on duplicate analyses, is estimated. These calculated precisions agree well with the errors propagated from the concentration formulas, and are 0.5 and 0.7% for uranium and plutonium, respectively. (auth)

22933 (ORNL-TM-2175) MODIFICATIONS OF THE ORNL MODEL Q-2564 HIGH-SENSITIVITY COULOMETRIC TITRATOR. Mueller, T. R.; Jones, H. C.; Fisher, D. J.; Stelzner, R. W. (Oak Ridge National Lab., Tenn.). Mar. 18, 1968. Contract W-7405-eng-26. 18p. Dep. CFSTI.

Modifications that were made to the circuit of the ORNL Model Q-2564 High-Sensitivity Coulometric Titrator are described. The method of current limiting was changed in order to prevent the driving of a control amplifier to voltage limit saturation, which resulted in hangup during recovery from limit. Related topics discussed include: needs for and methods of obtaining current limiting; overshoot of working electrode potential; the definition, cause, prevention, and minimization of hangup; hangup problems

in ORNL titrators Models Q-2005-X50 and Q-2564; and criterion for negligible transient overshoot of working electrode potential. The details of the modification of the Q-2564 circuit to prevent potentiostat hangup and to increase stability are included. Also, the method of attachment of the I-Q readout mode to the ORNL Model Q-2564 titrator is described. (auth)

22934 (PG-Report-615) THE DETERMINATION OF STRONTIUM IN BONE, MILK, AND VEGETABLE ASHES USING ION EXCHANGE SEPARATION AND FLAME PHOTOMETRY. Goodall, G. (United Kingdom Atomic Energy Authority, Capenhurst (England). Production Group). 1968. 16p. Dep. CFSTI. UK 3s. 0d.

A rapid and sensitive method for the determination of strontium in the presence of large amounts of calcium and other interfering elements found in biological materials was developed using cation exchange and flame photometry. Ammonium lactate was used as eluant and the strontium in the eluate was determined directly by flame photometry. The method has a negative bias of 3% and the strontium content of 0.2 grams of bone ash can be determined with a coefficient of variation of 2%. (auth)

22935 (SC-RR-68-138) SPECTROCHEMICAL ANALYSIS OF IMPURITIES SEPARATED FROM BORON BY ION EXCHANGE. Wanner, D. E.; Conrad, F. J. (Sandia Corp., Albuquerque, N. Mex.). Mar. 1968. 19p. Dep. CFSTI.

The impurities in boron were determined by separating the impurities by cation exchange followed by spectrochemical analysis. The sample was dissolved in nitric acid, then the boron content was reduced by volatilization as methyl borate. The boron level was reduced to a contaminant in the impurities by cation exchange. The resin was ashed, mixed with graphite powder, briquetted, and analyzed spectrochemically by AC spark excitation in an argon–oxygen atmosphere. The method is applicable to the determination of 15 impurities in boron samples. (auth)

22936 (TID-23214) OPTIMIZED GEOMETRY FOR COUPLING A MASS SPECTROMETER TO A SHOCK TUBE. Marsters, G. F.; Bauer, S. H.; Resler, E. L. Jr. (Cornell Univ., Ithaca, N. Y.). [1965]. Contract AT(30-1)-3211. 19p. Dep. CFSTI.

The problem of coupling a transient high-density source to the ionization section of a mass spectrometer was attacked. Although pin-hole leaks allow mass-spectrometric detection of free radicals generated by shock heating, it would be useful to have a method that might retain sample integrity more effectively. The in situ composition of the sample could be changed by mixing with boundary layer gas, since the length of molecular diffusion time, from the shock region to the ionizing electron beam, allows the sample to experience many collisions. If it was possible to expand rapidly and thus to cool and quench a portion of the axially located gas to sufficiently low density, fidelity of sampling would be achieved. The coupling section now under construction was designed to generate a high flux but not a well-collimated molecular beam for injection into the mass spectrometer ion source. The shock tube is operated in an open ended-mode and defining nozzles are introduced for successively draining off boundary layer gas. Optimization of expansion is achieved by inserting axial sleeves in the end of the shock tube, of diameters appropriate for several regimes of operation. Calculations of sample residence times and total average collision numbers are presented. (auth)

22937 (TRG-Report-1635) DETERMINATION OF CARBONATE IN SODIUM. Walker, J. A. J.; France, E. D. (United Kingdom Atomic Energy Authority, Culcheth (England). Reactor Group). 1968. 12p. Dep. CFSTI. UK 2s. 6d.

A method is described for the determination of sodium carbonate in sodium in the range 7 to 150 ppM with a standard deviation of not greater than 1.5 ppM. The principle of the method involves the removal of sodium by distillation and the conductometric determination of the carbon dioxide evolved after acidification of the distillation residue. It is shown that when a maximum distillation temperature of 350°C is used the decomposition of sodium carbonate in nickel crucibles is negligible. (auth)

22938 (EURFNR-418) POTENTIOMETRIC TITRATION OF FREE ACID AND PLUTONIUM IN NITRIC ACID PLUTONIUM SOLUTIONS. Vogg, H. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Heisse Chemie). Translation of report KFK-622. 22p. (EUR-3692). Dep. CFSTI.

Work performed under United States–Euratom Fast Reactor Exchange Program.

A method is described for the determination of free acid in plutonium solutions when the plutonium is present in quadrivalent form by oxidation of Pu(IV) into Pu(VI) using MnO_2. The free acid can then readily be titrated potentiometrically with alkali together with PuO_2^{++}, which has no disturbing effect. Pu was determined by titration of PuO_2^{++} by the peroxide method. A relative standard deviation of about 1.5% was assumed on the basis of experiments. The peroxide method was also used for a mixed (U + Pu) solution. (P.C.H.)

22939 DETERMINATION OF SMALL AMOUNTS OF MOLYBDENUM IN VANADIUM METAL AND IN VANADATES. Klug, Otto N.; Metlenko, Alexander I. (Inst. of Non-Ferrous Metals, Budapest). Chem. Anal. (Warsaw), 13: 15-16(1968). (In Polish).

Ion exchange and extraction methods for the separation of small amounts of molybdenum from vanadium have been devised. In the ion exchange procedure, the solution of vanadium(V) and molybdenum(VI) in 3 to 4 N HCl solution is passed through a column with Hungarian anion exchanger Varion AD (or Dowex 2 or AV-17, respectively). Mo(VI) is absorbed by the resin while vanadium passes through. Molybdenum is then eluted with 0.5 to 1 N NCl solution. The method can be applied to Mo contents of 0.05%. Two extraction methods were elaborated. In the first procedure Mo(VI) was extracted with ethyl ether from 6 N HCl solution, reextracted into 1 N HCl solution after addition of H_2O_2, reduced to Mo(V) transformed into $Mo(SCN)_5$, extracted with diisopropyl ether or n-amyl alcohol and absorbance of the extract was measured. The second procedure was limited to the direct extraction of $Mo(SCN)_5$. The best conditions for colorimetric determination of Mo as $Mo(SCN)_5$ were fulfilled when this compound was extracted into n-amyl alcohol. These methods were successfully applied to the determination of Mo in vanadium when Mo content was higher than 4 ppM. The relative error at the Mo content of 10 to 30 ppM was approximately 20%. (auth)

22940 RADIOCHEMICAL METHOD FOR DETERMINING THE COMPOSITION OF H_2S–H_2 GASEOUS MIXTURES. Barbouth, N.; Oudar, J. (Laboratoire de Chimie Appliquee, Paris). Bull. Soc. Chim. Fr., No. 3, 895-6(Mar. 1968). (In French).

A continuous analytical method for H_2S-H_2 gaseous mixtures by the use of radioactive sulfur and an original counting procedure is described. A study of the equilibrium $Cu-Cu_2S-H_2-H_2S$ shows the advantages of the method for speed and sensitivity in comparison with classical methods. (auth)

22941 PORTABLE APPARATUS FOR RADIOCHEMICAL ANALYSIS. Rygaert, J.; Beaudet, C. (SERAI, Brussels). Kerntechnik, 10: 92-7(Feb. 1968). (In English and German).

Different methods of radiochemical analysis, activation methods, dilution with isotopes, and exchange methods, are described. Two portable apparatus are described for the determination of chlorides and of dissolved oxygen in water. (auth)

22942 SOME NEW DEVELOPMENTS IN ACTIVATION ANALYSIS. Adams, F.; Hoste, J. (Univ. of Ghent). Kerntechnik, 10: 98-102(Feb. 1968).

Activation analysis can be used in a number of fields such as biology, medicine, criminology, and various industrial applications, due to recent refinements in irradiation facilities and measurement techniques. 14-MeV neutron generators now become increasingly used for industrially important determinations such as the analysis of oxygen in steel. Ge(Li) spectrometry allows the ready determination of traces in increasingly complex samples. (auth)

22943 ACTIVATION ANALYSIS IN FRANCE TODAY. Energ. Nucl. (Paris), 10: 29-34(Jan.-Feb. 1968). (In French).

The present characteristics and possibilities of activation analysis, which make it a useful addition to other analytical techniques, are reported. (M.C.G.)

22944 USE OF RADIONUCLIDES IN INDUSTRY. Proepstl, G. (Buero Eurisotop, Brussels). Kerntechnik, 10: 77-9(Feb. 1968). (In English and German).

The potential applications as well as the actual scope of applications of radionuclides in industry are discussed including radiometric, irradiation, nuclear reaction, and nuclear indicator techniques. (D.H.M.)

22945 NATURAL SELECTIVE GAMMA LOGGING. A NEW LOG OF DIRECT URANIUM DETERMINATION. Czubek, Jan A. (Inst. of Nuclear Research, Krakow). Nukleonika, 13: 89-105 (1968).

A new spectroscopic method for uranium detection is presented. The method is based on the influence of the photoelectric effect in uranium on the shape of the natural gamma spectrum at the low-energy region in the extended rock medium. The lower limit of detection depends on the geological conditions of each deposit, and the relative standard deviation of one observation is estimated to be 10 to 20%. (W.H.K.)

22946 DETERMINATION OF THORIUM IN ROCKS AND MINERALS BY SEPARATION OF INTERFERING ELEMENTS BY CHLOROFORM EXTRACTION OF CUPFERRONATES. Belopol'-

skii, M. P.; Gumbar, K. K.; Popov, N. P. Radiokhimiya, 10: 119-22(1968). (In Russian).

Gravimetric and photometric determination of thorium in aluminosilicates and rare element minerals was achieved by thorium separation from various elements forming strong cupferronates in acid media and by further separation of the cupferronates with chloroform. The optimum conditions for photometric determination with Arsenazo III in the presence of prevailing quantities of rare earths and Uranium (VI) were found. (R.V.J.)

22947 PHOTOCHEMICAL REACTIONS IN ANALYTICAL CHEMISTRY. COMMUNICATION 4. PHOTOMETRIC DETERMINATION OF URANIUM(VI) BY ACETALDEHYDE FORMED ON THE PHOTOCHEMICAL OXIDATION OF ETHANOL. Nemodruk, A. A.; Bezrogova, E. V. Zh. Anal. Khim., 23: 388-93(Mar. 1968). (In Russian).

A study was made of the photochemical oxidation of ethanol to acetaldehyde with uranium(VI) depending on the concentrations of uranium, ethanol, and sulfuric acid, and on the time of irradiation of the solution with a PRK-7 mercury-quartz tube. The acetaldehyde formed was determined with fushsin–sulfuric acid. During the photochemical oxidation of ethanol in the presence of oxygen the amount of acetaldehyde formed was practically a linear function of the uranium content in the irradiated solution. It increased with an increase in ethanol concentration and the time of irradiation. On irradiating the solution containing 70% ethanol the mean amount of acetaldehyde formed during 10, 20, and 30 min periods was 7.25, 23.2, and 51.2 mole, respectively, for 1 g-atom of uranium. The formation of much larger amounts of acetaldehyde than stoichiometric with respect to uranium might be due to repeated oxidation of uranium(IV) formed in the reaction to uranium(VI). When the solution was irradiated for 10 min it was possible to determine 2 to 40 μg of uranium by means of acetaldehyde formed in the reaction. Irradiation for 20 min permitted the determination down to 0.8 μg of uranium in a sample. (auth)

22948 THE USE OF PHOSPHORIC ACID DURING THE TITRIMETRIC DETERMINATION OF MOLYBDENUM, CHROMIUM, AND VANADIUM. Veselago, L. I. (Inst. of Metallurgy, Moscow). Zh. Anal. Khim., 23: 384-7(Mar. 1968). (In Russian).

A titrimetric method was developed for determining molybdenum in a phosphoric acid medium without its preliminary reduction. The method was applied to the determination of molybdenum in alloys containing W, Zr, Fe, Re, and Nb. A potentiometric method was developed for determining chromium and vanadium by the successive titration with iron(II) first of Cr(VI) → Cr^{3+} and V(V) → V(IV) together, then of V(IV) → V^{3+}. (auth)

22949 FLAME PHOTOMETER SPECIALIZED FOR CESIUM. Folsom, T. R.; Sreekumaran, C.; Weitz, W. E. Jr.; Tennant, D. A. (Univ. of California, San Diego). Appl. Spectrosc., 22: 109-14(Mar.-Apr. 1968).

A photometer system is described that allows very small traces of an element, such as cesium, to be determined quantitatively with greater precision than previously possible with flame-emission spectra. For example, with the system it is possible to replicate measurements of the cesium in quantities that are normally present in one liter of seawater (about 0.3 μg) with a standard error of less than two percent. Dilute cesium standard solutions can be compared significantly within a few parts per billion. The system consists of two photomultiplier tubes observing a flame simultaneously, from the same aspect, but each having a different optical filter interposed. Use is made of a beam splitter and two interference filters, one filter passing only a narrow band centered at the 8521.1-Å line of cesium, the other filter passing a nearby band not containing much of this emission but rather passing a sample of the background of the flame that contributes much of the total statistical fluctuation. Signals from these two phototubes are compared by suitable differential circuits, and are continuously recorded. A specialized automatic sample-changing system was developed to provide for precise timing of the burning of the sample and the standard solutions and to carry out aspirator washings immediately following the burning of each sample. Finally, means are provided for continuously monitoring the aspiration rate by recording the brightness of the background (off-peak) signal independently. (auth)

22950 DETERMINATION OF TRACE AMOUNTS OF RARE EARTH IMPURITIES IN YTTRIUM OXIDE. Nash, D. L. (Bell Telephone Labs., Inc., Murray Hill, N. J.). Appl. Spectrosc., 22: 101-4(Mar.-Apr. 1968).

Investigations were conducted to achieve optimum sensitivity for the determination of rare earths in yttrium oxide. A specific technique evolved for this analysis is described. A dc arc burning in a controlled atmosphere of argon and oxygen is used together with a spectrograph of very high dispersion in order to provide optimum signal-to-noise ratio. Because the excitation efficiency is not uniform along the entire height of the arc column, only the most efficient portion is transmitted to the slit. Without any treatment or concentration of the sample other than dilution with graphite powder, this method achieves sensitivities for the rare earths in yttrium oxide ranging from about 50 ppM for the least sensitive rare earths (Pr, Ce) to about 0.5 ppM for the most sensitive rare earths (Lu, Sc, Yb). (auth)

22951 SPECTROGRAPHIC DETERMINATION OF SMALL AMOUNTS OF THORIUM IN SILICATE ROCKS. Rusanov, A. K.; Alekseeva, V. M.; Ilyasova, N. V. (All-Union Scientific-Research Inst. of Mineral Materials, Moscow). Zh. Anal. Khim., 23: 373-6(Mar. 1968). (In Russian).

A direct spectrographic analysis of silicate rocks for thorium content ($1 \cdot 10^{-2}$ to 1%) using a carbon arc for the spectrum excitation and lutetium as an internal standard was developed. The error of a single determination (the variation coefficient) is 11%. Together with thorium it is possible to determine 14 rare earth elements at the concentrations of $n \times 10^{-4}$ to $n \times 10^{-3}$% of each element. When a 0.5 to 3 g rock sample is enriched in the thorium and rare earth content it is possible to determine $n \times 10^{-4}$ to 1×10^{-2}% of thorium with an error (the variation coefficient) of 20%, and from $n \times 10^{-5}$ to $n \times 10^{-3}$% and more of rare earths. (auth)

22952 ADDITION OF WATER TO SCINTILLATORS CONTAINING DIOXANE AND TOLUENE. Pinaud, N. (Faculte de Medecine et de Pharmacie, Toulouse); Serres, P.; Commanay, L.; Teyssier, J. L. Int. J. Appl. Radiat. Isotop., 19: 369-75 (Apr. 1968). (In French).

It was found that addition of dioxane to a scintillator, the fundamental constituent of which is toluene, made it possible to increase the permissible amount of water before precipitation. The decrease in light yield was, however, important. Addition of naphthalene prevented this drawback. (auth) (UK)

22953 PREPARATION OF BIOLOGICAL SAMPLES CONTAINING RADIOIODINE FOR RADIOACTIVITY MEASUREMENT. Zaduban, M.; Liptakova, G.; Horak, J. (Safarik Univ., Kosice, Czech). Int. J. Appl. Radiat. Isotop., 19: 327-31(Apr. 1968).

Various methods for the dissolution of biological material containing radioiodine are discussed. For routine analyses solution in a mixture of HNO_3–$AgNO_3$ or in hot NaOH is recommended. When subsequent determination of individual iodine-containing compounds is required, extraction of the radioiodine components into NaOH solutions by treatment with ultrasound is recommended. (auth) (UK)

22954 APPLICATION OF ACTIVATION ANALYSIS TO INCLUSIONS CONTAINING CHROMIUM. Iwamoto, Nobuya; Adachi, Akira (Osaka Univ.). Technol. Rep. Osaka Univ., 17: 329-33(Oct. 1967).

The Cr contents in inclusions of Fe–Cr alloys were determined by activation analysis. Maximum value obtained for the inclusion in 8% Cr alloy corresponded to the minimum O solubility near 8% Cr alloy from the equilibrium study. This fact might be explained by the variation of O partial pressure in equilibrium with Fe–Cr alloys. Studies of whether the chromite takes tetragonal structure according to the Jahn–Teller effect or not showed that inclusions formed in 5 and 18% Cr alloys decomposed to iron chromite and $(Fe \cdot Cr)_2O_3$ at temperatures above 700°C. This would indicate that the tetragonal chromite formed is not caused by this effect. (NSA of Japan)

22955 APPLICATIONS OF NEUTRONS IN CHEMISTRY. Goedkoop, J. A. RCN (Reactor Cent. Ned.) Meded., No. 29, 131-42(1967). (In Dutch).

The most important applications of neutrons in chemistry are based on the activation that usually results from the capture of a neutron in a nucleus. Besides indirect ways (such as the use of radioisotopes as tracers), the phenomenon is used directly in activation analysis, of which several examples are discussed. Besides capture, diffraction by the nucleus is possible. This process is the basis of the neutron diffraction technique, often used complementary to x-ray analysis of organic structure. In magnetic materials, neutrons are also diffracted by the electrons, which gives information on the arrangement of magnetic moments. The inelastic component of the scattering gives information about the interaction forces. (tr-auth)

22956 DATA ON THE ROCK GSP-1 (GRANODIORITE) AND THE ISOTOPE-DILUTION METHOD OF ANALYSIS FOR Rb AND Sr. Peterman, Zell E.; Doe, Bruce R.; Bartel, Ardith. U. S. Geol. Surv., Prof. Pap., 575-B, B181-6(1967).

Concentrations of selected elements in the U. S. Geological Survey standard granodiorite, GSP-1, as determined by isotope

dilution are 268 ppM of Rb, 240 ppM of Sr, 58.7 ppM of Pb, 2.4 ppM of U, and 106 ppM of Th. Duplicate analyses of Rb, Sr, and Pb agreed to within 1%. Replicate analyses of U and Th showed larger variations. The range of U values was ±20% of the mean and for the Th value, ±8% of the mean. The isotopic compositions of Pb and Sr are given, and the analytical techniques for determination of Rb and Sr are discussed. The $^{87}Sr/^{86}Sr$ ratio after normalization is 0.7687 ± 0.0011. The isotopic composition of lead is given by the following ratios: $^{206}Pb/^{204}Pb$, 18.077; $^{207}Pb/^{204}Pb$, 15.67; and $^{208}Pb/^{204}Pb$, 47.33. (auth) (Geo. Sci. Abstr.)

22957 ISOTOPE-DILUTION DETERMINATION OF FIVE ELEMENTS IN G-2 (GRANITE), WITH A DISCUSSION OF THE ANALYSIS OF LEAD. Doe, Bruce R.; Tatsumoto, Mitsunobu; Delevaux, M. H.; Peterman, Zell E. U. S. Geol. Surv., Prof. Pap., 575-B, B170-7(1967).

Concentrations of selected elements in the reference sample G-2 (granite) were determined by isotope dilution to be: Pb, 30.8 ppM; Rb, 74 ppM; Sr, 481 ppM; Th, 24.3 ppM; and U, 1.9 ppM. A statistical study of the analytical uncertainties involved in Pb-isotope analysis showed the uncertainties to be systematic and to closely approach those expected from fractionation of Pb isotopes within the mass spectrometer. The ranges in $^{206}Pb/^{204}Pb$ and $^{208}Pb/^{204}Pb$ on samples approach 4 times those expected from tests of the mass spectrometer, because of a sample-loading effect. The precision can be increased, approximately to a level expected only from mass spectrometer effects, by loading an amount of NH_4NO_3 solution proportional to the amount of Pb loaded. (auth) (Geo. Sci. Abstr.)

22958 POTENTIOMETRIC DETERMINATION OF MOLYBDENUM AS SILVER MOLYBDATE. Shivahare, G. C. (Univ. of Jodhpur, India). Z. Anal. Chem., 219: 187-8(1966).

At pH 7.2 to 7.6, Ag^+ can be titrated with MoO_4^{2-}, or vice versa, with a silver indicator-electrode and a standard calomel reference-electrode. (Anal. Abstr.)

22959 HIGH-FREQUENCY TITRIMETRIC DETERMINATION OF LEAD AND THORIUM WITH AMMONIUM MOLYBDATE. Prakash, Shri; Singh, R. P. (Univ. of Delhi). Indian J. Appl. Chem., 29: 59-63(1966).

Titrations of Pb (2.5 to 12 mg) at pH < 5.6 and of Th (1.6 to 16 mg) at pH ≃ 2.5 were carried out at 30 Mcps. The ratio of Pb to Mo in the precipitate was found to be 1:1, and that of Th to Mo was 1:2. Reverse titrations were also possible, but for Th distinct end points were obtained only for amounts from 0.2 to 2 mg in the presence of HNO_3 and ethanol. (Anal. Abstr.)

22960 SOLUTION TECHNIQUE FOR ANALYSIS OF SILICATES. Suhr, N. H.; Ingamells, C. O. (Pennsylvania State Univ., University Park). Anal. Chem., 38: 730-4(1966).

A rapid and precise method for determining most of the constituents of silicates on a single sample is described. The sample (0.1 g; <200 mesh) is mixed with 0.5 g of $LiBO_2$ and heated in a graphite crucible at 950°C for 10 to 15 min. The melt is dissolved in 50 ml of cold HNO_3 solution containing Co as internal standard [30 ml of concentrated HNO_3 and 50 ml of 0.565% aqueous $Co(NO_3)_2 \cdot 6H_2O$ diluted to one liter] in a Teflon or polypropene beaker. The solution is analyzed by emission spectrometry, with use of the rotating-disc technique. The standard Co lines (Å) are Co I 3453.5 and Co II 2286.2. Elements determined include Si, Al, Mg, Ca, Sr, Ba, Ti, Mn, Fe, Cr, Cu, Zn, Zr, V, and Ni. Sodium and K can be determined in the same sample solution by flame photometry. (Anal. Abstr.)

22961 POLAROGRAPHIC DETERMINATION OF COPPER, LEAD, CADMIUM, AND ZINC IN TECHNICAL AND HIGH-PURITY INDIUM. Neciu, S.; Aurelian, M. Rev. Chim. (Bucharest), 17: 357-8(1966). (In Rumanian).

For the direct determination of Cu, Pb, Cd, and Zn (≃0.1% each) in technical In, heat the sample (0.1 to 0.2 g) with HCl (d = 1.19) (10 ml) and aqueous H_2O_2 (a few drops), and evaporate the solution to dryness on a sand bath to remove the volatile chlorides of Sn, Sb, and Tl. Repeat this treatment, then add concentrated HCl (5 ml), and again evaporate to remove traces of H_2O_2. Moisten the residue with HCl (3 or 4 drops), add water (30 ml), and heat until dissolved. Dilute the solution with water to 100 ml, treat an aliquot (5 ml) with 2.5M ethylenediamine (5 ml), stir, add 2.5M KOH (5 ml) and 0.5% gelatin solution (1 ml), and dilute with water to 25 ml. Deaerate an aliquot (10 ml) by passage of N_2, and record the polarogram; 5 steps are obtained, the heights of which are proportional to the concentration of the 5 elements. The values (V) of $E_{\frac{1}{2}}$ are –0.42, –0.61, –0.95, –1.35, and –1.45 for Cu, Pb, Cd, In, and Zn, respectively. For high-purity In (containing 10^{-3} to 10^{-2}% of impurities), dissolve the sample (0.5 to 1 g) in concentrated HBr (10 ml) plus aqueous Br (a few drops), evaporate the solution to dryness, and repeat this treatment. Dissolve the residue in 4.5M HBr (10 ml), shake the solution with ethyl ether (30 ml) for 5 min (to remove most of the In), separate the layers, repeat the extraction once, if necessary, and evaporate the aqueous phase to dryness. Treat the residue with concentrated HCl (2 ml) and aqueous H_2O_2 (a few drops), and evaporate the solution almost to dryness; dissolve the solids in concentrated HCl, again evaporate, moisten the residue with HCl (a few drops) and dissolve it in water (25 ml), then carry out polarography as before. (Anal. Abstr.)

22962 ANIONIC COMPLEXES OF IODINE–IODIDE AND IODINE–THIOCYANATE IN NITROBENZENE. EXTRACTION OF THE CATIONS OF CAESIUM, SODIUM, AND HYDROGEN ASSOCIATED WITH THESE ANIONS. Tribalat, S.; Grall, M. (Faculte des Sciences, Paris). Compt. Rend., Ser. C, 263: 399-402(1966). (In French).

During the extraction of Cs^+ with nitrobenzene in the presence of iodine, I^-, or iodine, SCN^-, the presence of I_3^-, I_5^-, and I_4SCN^- in the solvent was established. The constants of the different partition equilibria and the constants of formation of I_3^- and I_5^- were determined. By using these values to select the optimum conditions, the selective quantitative extraction of Cs^+ in the presence of Na^+ or H^+ can be achieved, even when either of these species is in large excess. (Anal. Abstr.)

22963 SPECTROCHEMICAL METHOD FOR THE DETERMINATION OF TRACE IMPURITIES IN METALLURGICAL MATERIALS. Balfour, B. E.; Jukes, D.; Thornton, K. (Henry Wiggin and Co., Ltd., Hereford, Eng.). Appl. Spectrosc., 20: 168-71(1966).

A method is described for the simultaneous determination of Ag, As, Au, Bi, Cd, Ge, In, Mo, Pb, Sb, Sn, and Tl. Preconcentration and separation are achieved by coprecipitation with CuS, and excitation is achieved by means of a dc arc. The analysis of a wide variety of materials with a single set of synthetic standards is possible. The overall coefficient of variation is between 5 and 10%. (Anal. Abstr.) (TSS)

22964 HOMOGENEOUS PRECIPITATION OF LEAD MOLYBDATE. [DETERMINATION OF MOLYBDENUM]. Newcomb, G. Jr.; Markham, J. J. (Villanova Univ., Pa.). Anal. Chim. Acta, 35: 261-2(1966).

A method for the determination of Mo is based on the precipitation of MoO_4^{2-} by Pb^{2+} ions displaced slowly from the Pb–EDTA complex by reaction with Cr^{3+}. A sample containing ≃55 mg of Mo is mixed with 21 ml of 0.1M EDTA (disodium salt); the pH of the solution is adjusted to 4 with dilute acetic acid or aqueous NaOH; and the solution is diluted to 50 ml. The solution is covered and heated nearly to the boiling point. Then 15 ml of 0.1M $Pb(NO_3)_2$ is added slowly with magnetic stirring. If the solution becomes cloudy, more 0.1M EDTA is added. The solution is boiled gently for 1 min, and then 6.5 to 7 ml of 2.1M $Cr(NO_3)_3$ is added, and the solution is further boiled for 10 min. The solution is then cooled to 40°C. The precipitate is washed by decantation with water until it is colorless; then it is collected on a glass-fiber pad, heated at 200°C to a constant weight, and weighed as $PbMoO_4$. (Anal. Abstr.) (TSS)

22965 SPECTROPHOTOMETRIC DETERMINATION OF ALUMINUM WITH ERIOCHROMECYANINE R AND CETYLTRIMETHYLAMMONIUM CHLORIDE. Shijo, Yoshio (Univ. of Utunomiya, Japan); Takeuchi, Tsugio. Bunseki Kagaku, 17: 323-7(Mar. 1968). (In Japanese).

Chelometric titration of various metal ions with TTHA (Triethylenetetraminehexaacetic acid) can be performed in quite similar way as that with EDTA. The color changes of indicators are, however, sluggish in general, and some of them give end points hardly distinguishable. The mixture of metal ions which react with TTHA in the ratio of 1:1 and 2:1 (metal:ligand), respectively, may be titrated selectively. In the mixture of calcium and magnesium optimum conditions common for both ions were not found. Among the other combinations of metal ions, mixtures of calcium with nickel, zinc, and cadmium, mixtures of cerium with lead, zinc, and mercury, and mixtures of lanthanum with lead, zinc, and cobalt, a satisfactory result was obtained only in the mixture of lanthanum and mercury. In order to evaluate the TTHA titration, the theoretical titration curves of calcium and magnesium were derived by calculations using the equilibrium data of 1:1, 2:1, and 3:1 complexes, as well as monohydrogen and dihydrogen complexes. Somewhat sluggish color change of the indicator near the end point is explained by the increase of pM at the earlier stage of titration. (auth)

22966 POLAROGRAPHIC DETERMINATION OF THE SOLUBILITY OF MOLYBDENUM AND ZINC IN FERTILIZER. Prot-

senko, G. P.; Kovalenko, P. N. Agrokhimiya, No. 3, 127-30 (1966). (In Russian).

The determination of Mo (≈0.01%) and Zn (20 to 25%) in fertilizers also containing Fe, Al, Mg, Mn, Cu, Ni, and Cr is described. The basal solution is 0.5N HNO_3 for Mo ($E_{\frac{1}{2}}$ = −0.17 V vs. the S.C.E.), and 0.5N $LiNO_3$ containing gelatin for Zn ($E_{\frac{1}{2}}$ = −0.97 V). The results agree with those of spectrographic determination. The methods have been used to study the solubility of the fertilizers and the transfer of Mo and Zn from them into the aqueous phase. (Referativnyi zh. 1967)

22967 DETERMINATION OF TANTALUM IN NATURAL AND INDUSTRIAL WASTE WATER. Pets, L. I.; Aleskovskii, V. B.; Miller, A. D. Zh. Prikl. Khim., 39: 1190-2(1966). (In Russian).

The method is suitable for determining ≈8 to 10 μg of Ta per liter of water. Tantalum is co-precipitated with $CaCO_3$ (250 mg) or CdS (30 mg) at pH 10 in the presence of a small amount of Fe^{3+} to increase the degree of precipitation of Ta and to help to coagulate the precipitation. The $CaCO_3$ precipitate is dissoved in 35% citric acid (10 ml), then 0.15M-EDTA (2 ml) is added, and Ta is extracted for 10 min into 5 ml of 0.1M-trioctylamine in xylene. The extract is evaporated to dryness, then the residue is fused with $KHSO_4$ and Ta is determined by the extraction-photometric method with Rhodamine 6G (C.I. Basic Red 1) (cf. Pavlova and Blyum, Analyt. Abstr., 1963, 10, 3665). The CdS precipitate is treated with 10% NaOH solution (0.2 ml) and H_2O_2 (0.4 ml), then evaporated to dryness. The residue is dissolved in 0.1 to 0.2 ml of H_2SO_4 (1 :1), and Ta is determined as described above. (Analytical Abstr. No. 9, 1967)

22968 X-RAY FLUORESCENCE ANALYSIS FOR RUBIDIUM, STRONTIUM, BARIUM, AND LEAD IN KAOLINS AND CLAYS. Koester, H. M. (Technische Hochschule, Munich). Contrib. Mineral. Petrol. (Berlin), 12: 168-72(1966). (In German).

Dried powdered samples of clay or clay minerals were compressed, and the x-ray fluorescence spectra were compared with those of the same materials to which were added small amounts of Rb, Sr, Ba, or Pb. A homogeneous distribution of these elements in the samples was obtained by the precipitation of Pb, Ba, and Sr as sulfates and of Rb as the tetraphenylborate in a concentrated suspension of the sample. The prepared suspensions were filtered (by using membrane filters), and the solids were dried before compression and exposure to x-rays. A LiF analyzing crystal is used, in conjunction with a molybdenum target at 50 kV and 30 mA. The concentration ranges studied and standard deviations obtained (both in ppM) were—Rb, 25 to 150, ±3; Sr, 200 to 400, ±6; Ba, 1000 to 2000, ±60; and Pb, 250 to 800, ±9. (Anal. Abstr. Sept. 1967)

22969 DETERMINATION OF CERTAIN RARE-EARTH ELEMENTS IN THE ASH OF PLANTS AND SOILS BY THE METHOD OF NEUTRON ACTIVATION. Lobanov, E. M.; Khotamov, Sh.; Kist, A. A. (Umarov Physics-Engineering Inst., Dushanbe, USSR. Nuclear Physics Inst., Tashkent). Dokl. Akad. Nauk Tadzh. SSR, 9: No. 9, 12-16(1966). (In Russian).

Artemisia terrae albae, wormwood ash, was irradiated in a stream of 1.8×10^{13} neutrons/cm², with a 40-hour holding period. A complete γ spectrum of the sample was used and decay curves were plotted for accurate identification of individual γ-emitters and separation of individual photopeaks, followed by graphical analysis. From the Compton distribution of ^{24}Na and ^{46}Sc the contribution from ^{24}Na was determined by comparison with a standard. Results were compared with those from radiochemical separation of La, Ce, Sm, and Lu. Accuracy was 5 to 12 percent. (JPRS)

22970 AUTOMATIC SPECTROPHOTOMETRIC ANALYSIS OF [DEUTERIUM OXIDE FOR VARIOUS IONS PRESENT IN] CONCENTRATIONS OF THE ORDER OF PARTS PER 10^9. Britt, R. D. Jr. (E. I. du Pont de Nemours and Co., Aiken, S. C.). Tech. Eau (Brussels), No. 238, 29-33(1966). (In French).

An AutoAnalyzer was used in determining from 1 to 100 parts per 10^9 of certain ions in deuterium oxide. Chloride was determined by its reaction with $Hg(SCN)_2$–$Fe(NO_3)_3$ in 10% dioxane medium; the sum of NO_2^- and NO_3^- was determined (after reduction of NO_3^- with hydrazine–$CuSO_4$ in the presence of acetone) by treatment with sulfanilic acid solution and coupling the diazotized sulfanilate with 1-naphthylamine; NO_2^- alone was then determined by omitting the reduction step. Bivalent Fe was determined with 2,4,6-tripyridyl-1,3,5-triazine; if the sum of Fe^{2+} and Fe^{3+} is to be determined, hydroxylamine is also used. Ammonia was determined by the phenol–ClO^- reaction. By use of an expanded-scale colorimeter, maximum sensitivity and precision were attained. (Analytical Abstr. No. 1, 1968)

22971 DETERMINATION OF NIOBIUM IN METALS AND ALLOYS. Williams, A. I. (National Physical Lab., Teddington, Eng.). Analyst, 92: 43-6(Jan. 1967).

A method is described for the determination of niobium in metals and alloys. Niobium is separated from the matrix elements by adsorption on to Dowex 1 anion-exchange resin from a solution of hydrofluoric acid and nitric acid. The niobium is eluted in a mixture of hydrofluoric and nitric acids and determined by the spectrophotometric measurement of the blue complex formed between niobium(V) and bromopyrogallol red. The method was applied to the determination of niobium in iron, steel, tantalum, and zirconium. (auth) (UK)

22972 DIRECT TITRIMETRIC MICRODETERMINATION OF URANIUM. Saxena, O. C. (Univ. of Allahabad, India). Mikrochim. Acta, No. 2, 448-51(1968).

A direct titrimetric method for the estimation of uranium(VI) in the range of 0.7 to 76 mg was used by decomposing and oxidizing the complex, $\{U(VI)O_2 \cdot U(V)O_2 \cdot Fe(CN)_6\}$, with ceric sulfate. The mixed valency state in the above mentioned complex was confirmed by magnetic measurements, the isolated complex being paramagnetic. Na^+, K^+, Cs^+, Ca^{2+}, Sr^{2+}, Mg^{2+}, Be^{2+}, Pd^{2+}, La^{3+}, Ir^{3+}, Ru^{3+}, and Te^{4+} did not interfere but Ag^+, Tl^+, Cu^{2+}, Ba^{2+}, Co^{2+}, Ni^{2+}, Zn^{2+}, Pb^{2+}, Hg^{2+}, Sn^{2+}, Bi^{3+}, Au^{3+}, Rh^{3+}, Sb^{3+}, In^{3+}, Ti^{3+}, Th^{4+}, Zr^{4+}, Pt^{4+}, V^{5+}, Se^{6+}, Mo^{6+}, and Os^{8+} did. (auth)

22973 TRACE DETERMINATION OF NICKEL BY COMBINING PAPER CHROMATOGRAPHY WITH RADIOMETRIC PRECIPITATION. Chiotis, E. L.; Welford, G. A.; Morse, R. S. (Health and Safety Lab., New York). Mikrochim. Acta, No. 2, 297-303 (1968).

A technique combining chromatographic separation with radiometric precipitation was used for the determination of nickel in steels in the microgram to submicrogram range. An appropriate solvent completely isolated nickel from interference on a chromatographic strip. Nickel was then precipitated as the ^{35}S labeled nickel sulfide. Quantitative yields were obtained using radioautography and radiometry. (auth)

22974 QUALITATIVE AND QUANTITATIVE ISOTOPIC ANALYSIS OF ETHYL GROUPS CONTAINING BOTH HYDROGEN AND DEUTERIUM ($CH_xD_{3-x}CH_yD_{2-y}$) BY COMBINED NMR AND MASS SPECTROSCOPY. Saur, W.; Crespi, H. L.; Harkness, L.; Norman, G.; Katz, J. J. (Argonne National Lab., Ill.). Anal. Biochem., 22: 424-30(Mar. 1968).

A procedure for the qualitative and quantitative analysis of mixtures of compounds with partially deuterated ethyl groups is presented combining mass spectroscopy and proton magnetic resonance spectroscopy. In a mixture of partially deuterated ethyl acetates, all of the isotopic components were determined with a relative error of ±1.5% down to a concentration of 5 mole %. (D.H.M.)

22975 THENOYLTRIFLUOROACETONE AS EXTRACTANT AND COLORIMETRIC REAGENT FOR RUTHENIUM(III). Rangnekar, Asha V.; Khopkar, S. M. (Indian Inst. of Tech., Bombay). Mikrochim. Acta, No. 2, 272-6(1968).

2-Thenoyltrifluoroacetone was used for the extractive spectrophotometric determination of ruthenium at p_H 4.0 (acetate buffer). Beer's law was obeyed over the range 6 to 42 μg/ml at 450 nm. The color was stable for 72 hours. The metal can be separated from several noble and other metals by use of this method. (auth)

22976 DETERMINATION OF COPPER, COBALT, AND NICKEL BY CIRCULAR THIN-LAYER CHROMATOGRAPHY. Hashmi, M. H.; Shahid, Maqbool Ahmad; Chughtai, Farhat Rafique (Pakistan Council of Scientific and Industrial Research, Lahore). Mikrochim. Acta, No. 2, 309-15(1968).

A method for the microdetermination of copper, cobalt, and nickel in a mixture containing 40 metal ions by a circular thin-layer chromatographic technique is described. The procedure is simple; the chromatoplate takes about 2 minutes for its development and other metal ions do not interfere with the determination. The recovery of copper, cobalt, and nickel is better than 98%. The apparatus for the concentration of test solution before TLC analysis is also described. (auth)

22977 NEW MIXED CARRIER FOR THE SPECTROGRAPHIC DETERMINATION OF IMPURITIES IN HIGH PURITY URANIUM OXIDES. Day, G. T.; Serin, P. A.; Heykoop, Klaas (Eldorado Mining and Refining Ltd., Port Hope, Ont.). Anal. Chem., 40: 805-7(Apr. 1968).

In order to increase the sensitivity of boron and improve the precision of the refractory elements in the spectrographic determination of impurities in high purity uranium oxides, strontium fluoride with Ga_2O_3 added to produce smoother burn was investigated as a carrier. Best results were obtained with a mixture of one part SrF_2 and two parts Ga_2O_3 added to U_3O_8 to give a 4% mixture. A venting tool was designed to provide a high degree of compactness of the charge and a small center chimney. The action of

the mixed Ga_2O_3:SrF_2 carrier can be divided into two separated phases. The first phase involves the fractional distillation of impurities from the electrode and the second phase excitation in the plasma. Concentration ranges and precision data for U_3O_8 impurities (16 elements) are tabulated. (D.H.M.)

22978 CATHODOLUMINESCENCE AS AN ANALYTICAL TECHNIQUE FOR DETERMINATION OF RARE EARTHS IN YTTRIA. Wickersheim, K. A.; Buchanan, R. A.; Sobon, L. E. (Lockheed Research Labs., Palo Alto, Calif.). Anal. Chem., 40: 807-9(Apr. 1968).

Results from a broad study of the cathodoluminescent properties of the rare earths as activators for yttrium oxide showed that excitation techniques could be applied effectively to the determination of very small concentrations of rare earths in yttria. As an example, the determination of dysprosium in yttrium oxide is described. Dysprosium exhibits, in yttrium oxide, a very sharp emission line at 5720 Å. The dependence of emission intensity on dysprosium content became linear below about 10^{-3} mole %. Since the presence of other rare earths that quench the emission of the rare earth being determined limits the applicability of this luminescent technique at higher concentration levels, the usefulness of the technique is limited to systems where all rare earths that can quench one another are present at a total concentration of less than 10 ppM. The principal advantages and disadvantages of uv, x-ray, and electron excitation methods of yttria analysis for rare earths are given. (D.H.M.)

22979 SPECTROPHOTOMETRIC DETERMINATION OF TUNGSTEN AS THE TUNGSTATE BY HETEROPOLY ACID FORMATION. Guyon, John C.; Marks, Jerry Y. (Univ. of Missouri, Columbia). Anal. Chem., 40: 837-8(Apr. 1968).

A spectrophotometric method for the determination of tungsten is described that involves the formation of an assumed molybdotungstic acid in a weakly acidic medium and subsequent reduction to the heteropoly blue after a short period for complex formation. The method is simple and quite accurate for tungsten as tungstate in the concentration range of 0 to 15 ppM. The levels of interference of 12 diverse ions are tabulated. (D.H.M.)

22980 TECHNIQUE FOR THE EVALUATION OF SYSTEMATIC ERRORS IN THE ACTIVATION ANALYSIS FOR OXYGEN WITH 14-MeV NEUTRONS. Nargolwalla, S. S.; Crambes, M. R.; DeVoe, J. R. (National Bureau of Standards, Washington, D. C.). Anal. Chem., 40: 666-71(Apr. 1968).

In comparative 14-MeV neutron activation analysis for oxygen, the neutron and gamma ray attenuation differences in the sample and standard introduce systematic errors. A quantitative evaluation of these attenuation processes in a wide range of matrices and for three sample diameters is given. The experimentally determined correction factor, in each case, shows an exponential dependence on the calculated difference between the appropriate attenuation coefficients for sample and standard. Within the range of sample diameters tested, preliminary data indicate that the slope of each calibration line is linearly dependent on the sample diameter. For comparable diameters, the magnitude of the slope for neutron attenuation is approximately ten times greater than for gamma attenuation. These calibration lines are used to predict attenuation correction factors for the determination of oxygen in other matrices. Some typical analyses of Standard Reference Materials, corrected for attenuation, illustrate the high degree of accuracy and precision obtained. (auth)

22981 USE OF A DUAL SAMPLE-BIAXIAL ROTATING ASSEMBLY WITH A PNEUMATIC TUBE TRANSFER SYSTEM FOR HIGH PRECISION 14-MeV NEUTRON ACTIVATION ANALYSIS. Lundgren, F. A.; Nargolwalla, S. S. (National Bureau of Standards, Washington, D. C.). Anal. Chem., 40: 672-7(Apr. 1968).

Imprecision in 14-MeV neutron activation analysis is primarily caused by nonhomogeneity and anisotropy in the usable neutron flux. This fact is considerably magnified in analyses pertaining to short-lived radioactivity such as in the determination of oxygen by $^{16}O(n,p)^{16}N$ reaction. A design for a variable-speed dual sample rotating assembly is described. This assembly allows reproducible placement of pneumatically injected samples and permits both sample and standard to be exposed to an identical neutron flux as a result of biaxial rotation. The analytical precision, which is now most often limited by the total number of counts accumulated, is about ten times better than that which most standard normalization techniques can provide. The system permits the analyst to determine both neutron and gamma attenuation in dense samples. This irradiation assembly is currently being utilized for the accurate and precise determination of oxygen in NBS Standard Reference Materials. (auth)

22982 PROMPT ACTIVATION ANALYSIS FOR ^6Li. Sedlacek, W. A.; Ryan, V. A. (Univ. of Wyoming, Laramie). Anal. Chem., 40: 678-82(Apr. 1968).

Activation analysis in which sample, detector, (and flux monitor) are placed in a particle flux, and in which prompt events are counted and stored while bombardment continues has been called "prompt activation analysis." The reaction $^6Li_3(n,\alpha)^3H_1$ was so used to determine ^6Li in minerals and laboratory chemicals. A thin, uniform, reproducible film containing the lithium, exposed to a slow neutron flux, produced alpha particles and tritons. The latter were counted using a solid state detector mounted to the film, and using multichannel pulse height analysis. Mounted nearby in a "flat" region of the flux was a similar film and solid state detector. Triton counts from this were related to the neutron flux intensity. By calibration against separated isotopes, results within 1% may be rapidly obtained. (auth)

22983 REMOTE ANALYSIS OF RADIOACTIVE ALLOYS FOR CARBON, OXYGEN, NITROGEN, AND HYDROGEN. Goodspeed, Harvey T.; Holt, Ben D.; Marsh, John H. Jr.; Stoessel, John E. (Argonne National Lab., Ill.). Anal. Chem., 40: 682-5 (Apr. 1968).

Combustion and inert gas fusion methods were applied to the determination of carbon, oxygen, nitrogen, and hydrogen in alloys of high alpha, beta, and gamma radioactivity. The combustion and fusion furnaces were designed so that either could be used with a common shielding facility, energy supply, and analytical train. Sample addition, crucible replacement, and reaction tube exchange could be performed remotely using masterslave manipulators. Provisions were made to strip the carrier gas streams of radioactive and/or interfering gases before entering the measurement components of the analytical train. Advantages of the new furnace tubes, other than permitting remote handling, are noted. (auth)

22984 SOLVENT EXTRACTION-X-RAY SPECTROMETRIC MEASUREMENT OF MICROGRAM QUANTITIES OF TANTALUM. Hakkila, E. A.; Hurley, R. G.; Waterbury, G. R. (Los Alamos Scientific Lab., N. Mex.). Anal. Chem., 40: 818-20(Apr. 1968). (LA-DC-9225).

A study of the extraction of tantalum from either a nitric–hydrofluoric or a hydrofluoric–hydrochloric acid aqueous phase into hexone led to the development of a method for the separation and x-ray fluorescence measurement of microgram quantities of tantalum in silver. The relative standard deviation in the hexone extraction and x-ray fluorescence measurement of 1 μg to 10 μg of tantalum was 25% or less. The standard deviation of the concentration-x-ray measurement (without the extraction separation) was generally about half the value obtained when the extraction step was included. The standard deviation for measuring a blank was 0.13 μg, indicating that the lower limit of reliable measurement was approximately 0.4 μg of tantalum (3σ). Twenty-three elements were tested for interference in the analysis. (D.H.M.)

22985 DETERMINATION OF CARBON IN SODIUM BY PHOTON ACTIVATION ANALYSIS. Lutz, G. J.; De Soete, D. A. (National Bureau of Standards, Washington, D. C.). Anal. Chem., 40: 820-2(Apr. 1968).

A photon activation technique for the determination of C in Na is described that allows the possibly contaminated surface to be removed after irradiation, and an analysis representative of only the bulk of the sample to be obtained. The technique is free from a blank and the sensitivity is only limited by the radioactivity induced in the sample and the detection background. The sample was irradiated for 20 min with bremsstrahlung; then etched in 3 separate mixtures of ethanol and 10% water. Approximately 25% of the sample was dissolved, thus assuring removal of any surface contamination. The sample was then ignited and after addition of H_2SO_4, CO_2 was liberated. The CO_2 was trapped in NaOH solution after an absorption bulb containing H_3BO_3 solution in H_2SO_4 removed any radiofluorine as a fluoboric acid complex. The separation and collection were reproducible and quantitative with the complete separation requiring about 15 min. The radioactive CO_2 was then counted. Since an unknown quantity of Na was removed during the etching procedure and the samples and standards were irradiated separately, an internal standard method was utilized. The detection limit can be set at 0.5 μg of C, the errors of the first and second kind being 5% each. If desired, samples of about 3 g of Na can be accommodated. (D.H.M.)

22986 THE INTERACTION OF URANIUM(VI) AND ARSENAZO III IN PERCHLORIC ACID SOLUTIONS. Nemodruk, A. A.; Palei, P. N.; Glukhova, L. P. Zh. Anal. Khim., 23: 214-20(Feb. 1968). (In Russian).

The behavior of arsenazo III in perchloric acid solutions and its interaction with uranium(VI) were studied. In contrast with nitric and hydrochloric acid solutions, arsenazo III in 10 to 12M

$HClO_4$ solutions displayed a green coloration due to the change of the azoid form into the quinone-hydrazonic form of the reagent. For the determination of uranium in perchloric acid solutions using arsenazo III the optimum concentrations are 5.6M perchloric acid and from $9.0 \cdot 10^{-6}$ to $1.35 \cdot 10^{-4}$M arsenazo III. Beer's law is valid for solutions containing down to 2.5 μg/ml of uranium. Arsenazo III and uranium react at a ratio of 1:1. Two maxima were observed on the light absorption curve: one at 610 nm and the other at 656 nm. The molar extinction coefficients at the above wave lengths were found to be 48,900 ± 500 and 75,000 ± 500, respectively. (auth)

22987 DETERMINATION OF OXYGEN DISSOLVED IN A LIQUID BY THE ISOTOPE-DILUTION METHOD. Mukhin, N. N.; Aleskovskii, V. B. (Leningrad Technological Inst.). Zh. Anal. Khim., 23: 249-54(Feb. 1968). (In Russian).

Oxygen dissolved in various liquids was determined by the isotope-dilution method using oxygen containing 6% of ^{18}O as an indicator. There was no need for calibration, and the chemical properties of the liquid analyzed did not affect the results of the determination. The error of the method was no greater than 5%. The determinable minimum was 3×10^{-7}M. (auth)

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Refer also to abstracts 23039, 23117, and 23707.

22988 (BARC-307) STRUCTURAL CONSIDERATIONS IN SURFACE REACTIONS WITH URANIUM OXIDES. Karkhanavala, M. D. (Bhabha Atomic Research Centre, Bombay (India)). 1967. 20p. Dep.

Gas-solid reactions involving uranium oxides are discussed according to whether the uranium oxide acts as the solid substrate or the gaseous molecule. The reactions taking place on a urania or urania-base catalyst surface are illustrative of reactions of the first type, in which it is shown that the variable valency and the consequent changes in ionic radius of the uranium ions are of considerable importance. The possible gas-solid reactions taking place on a solid uranium oxide (UO_2) surface exposed to an environment containing oxygen are postulated and discussed from considerations of crystal chemistry. The important role of point group symmetries of the gaseous molecule and of the substrate surface, in determining the course of gas-solid surface reactions of the second type is elucidated and illustrated from reactions of gaseous UO_3 with different solids (oxides). The extension of this principle to other gas-solid reactions is suggested. (auth)

22989 (BNL-12212) DIFFUSION OF IODINE IN URANIUM MONOCARBIDE. Castleman, A. W. Jr.; Munkelwitz, H. R. (Brookhaven National Lab., Upton, N. Y.). Jan. 1968. 5p. (CONF-680601-1). Dep.

For Presentation at 14th Annual Meeting of the American Nuclear Society, Toronto, Ontario.

The diffusivity of iodine in UC was measured over the temperature range 1524 to 1760°C utilizing a continuous flow technique. Prior to an experiment, each of the specimens was irradiated to an integrated dose of 3×10^{18} n/cm² to build up a sufficient iodine concentration for radioactive-tracer measurements. Results, which are shown on a plot of the diffusion coefficient of iodine in the UC as a function of the reciprocal absolute temperature, indicate that diffusion within the grain is the rate-controlling process. The activation energy of 110 kcal/mole for iodine diffusion is approximately 25 kcal/mole larger than the activation energies reported for carbon and uranium self-diffusion in the carbide. (D.H.M.)

22990 (CEA-R-3265) CONTRIBUTION A L'ETUDE DE L'EVAPORATION DE SOLUTIONS AQUEUSES DE NITRATE D'URANYLE. (Contribution to the Study of Evaporation of Aqueous Solutions of Uranyl Nitrate). Billy, Jean (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Jan. 1968. 63p. (In French). Dep.

Thesis. Submitted to University of Paris, France.

Work was carried out with a view to define the conditions under which the concentration of aqueous uranyl nitrate solutions, one of the steps in uranium extraction metallurgy, is effected. The physical characteristics of aqueous uranyl nitrate solutions were determined. Isothermal evaporation of solutions was carried out in a wet-wall column; this chemical engineering study was more particularly devoted to the definition of the influence of the dynamics of the liquid phase on the exchange of matter between the two phases in contact. (auth)

22991 (CONF-670502-, pp 175-86) CHEMICAL AND ELECTRON OPTICAL STUDIES OF SOLS, GELS, AND OXIDE MICROSPHERES PREPARED FROM RARE-EARTH HYDROXIDES. Hardy, C. J.; Buxton, S. R.; Willmarth, T. E. (Oak Ridge National Lab., Tenn.).

Hydroxides of individual rare earths, principally praseodymium, neodymium, and europium, were precipitated from nitrate solutions with ammonium hydroxide, washed with water, and aged at 25 and 80°C to form sols containing about 0.5M metal hydroxide and a small amount of nitrate. Gel spheres of 100 to 800 μ diameter were prepared by partial dehydration of droplets of sols suspended in 2-ethylhexanol. The structure of the precipitates, sols, and gels was examined by electron microscopy and electron diffraction. The initial precipitates of praseodymium and neodymium hydroxides consisted of amorphous particles of 30 to 60 Å diameter. The washed precipitates changed over a period of 1 to 2 hours at 25°C into translucent sols, which contained rod-shaped crystals of the trihydroxides loosely aggregated into bundles 600 to 1000 Å long and 50 to 100 Å wide. The hydroxides of europium and heavy rare earths formed similar sols of low viscosity and low pH (7) only after the precipitates were aged for many hours at 25° or 1 to 2 hours at 80°C, and the aggregates of rods grew much larger (up to 3 μ long). The amorphous particles appeared to aggregate into net-like sheets; these broke up into small rod-shaped crystals, which aggregated into bundles and slowly increased in length. The bundles were oriented randomly in the gel spheres, but were packed in regular arrays in precipitates that had sedimented slowly. Spheres of rare earth oxides of 50 to 500 μ diameter prepared by programmed heating of gel spheres to 900 to 1450°C had densities of 95 to 98% of the theoretical crystal densities, low surface areas, and high crushing strength. The preparation, properties, and structure of europium oxide spheres was examined in detail because of their applications in the nuclear field. Electron micrographs of replicas of fractured, and polished and etched, surfaces of the europium oxide spheres showed small grains of 300 to 500 Å in the cubic oxide at 900°C, and large grains of 5 to 10 μ in the monoclinic oxide heated at 1450°C. The large grains contained highly ordered subunits of 0.2 to 0.5 μ, but these were probably polycrystalline because x-ray line-broadening indicated crystals of 500 to 750 Å. (auth)

22992 (CONF-670502-, pp 187-93) STRUCTURE OF LANTHANUM DIHYDROXY CHLORIDE. Carter, Forrest L. (Naval Research Lab., Washington, D. C.).

Prepared hydrothermally $La(OH)_2Cl$ crystallizes in a monoclinic form with unit cell parameters of a = 6.318, b = 3.993, and c = 6.931 Å and $\beta = 113.86°$. The structure is noncentrosymmetric and belongs to the $P2_1-C_2^2$ space group. Lanthanum has a coordination sphere of eight, of which two chlorines and four oxygens form a distorted trigonal prism. The structure is primarily a layer type with a structural backbone of lanthanum and oxygen. Hydrogen bonds between the hydroxyl groups and chlorine are responsible for the interlayer bonding. (auth)

22993 (CONF-670502-, pp 239-48) Eu^{+3} FLUORESCENCE IN NON-RARE EARTH OXIDE HOSTS. Borchardt, Hans J. (Du Pont de Nemours (E. I.) and Co., Wilmington, Del.).

Attempts were made to dope a variety of non-rare earth oxides with Eu^{3+}. Of 19 oxides tried only ThO_2 gave a bright phosphor. Failure of the others is attributed to low Eu^{3+} solubility. $(ThO_2)_{0.98}(EuF_3)_{0.02}$ is a highly efficient phosphor with a quantum efficiency of about 0.64 under 2537 Å excitation. It is reported to be the first high efficiency Eu^{3+} phosphor not to contain a second rare earth ion and to have such a low optimum Eu^{3+} concentration. (auth)

22994 (CONF-670502-, pp 249-58) ENERGY TRANSFER IN CRYSTALS DOUBLY DOPED WITH RARE EARTHS. Esterowitz, L.; Bahler, J.; Noonan, J. (Army Night Vision Lab., Ft. Belvoir, Va.).

It was demonstrated that the infrared quantum counter (IRQC) fluorescence may be increased by using two species of rare earth impurity ions. The effects on the energy cascade were studied as the sensitizer (Yb^{3+}) concentration was increased. In particular, level bypassing of the Ho^{3+} (activator), $^5F_3$, state was attributed to a resonant energy cross-relaxation process. (auth)

22995 (CONF-670502-, pp 259-70) THE ENERGY LEVELS OF TETRAVALENT DYSPROSIUM. FLUORESCENCE AND ABSORPTION SPECTRA OF CESIUM DYSPROSIUM(IV) HEPTAFLUORIDE. Varga, Louis P.; Asprey, Larned B. (Los Alamos Scientific Lab., N. Mex.).

When cesium salts of dysprosium containing 3:1 mole ratio cesium:dysprosium are reacted for several hours with fluorine gas at 200 to 250°C and 50 to 60 psig, the white Dy(III) salt is converted to a bright orange material with an empirical formula approaching Cs_3DyF_7. Absorption and fluorescence spectra, of

fluorocarbon mulls of this material at liquid N_2 temperatures were taken using continuous recording spectrophotometers and the low-lying f^n transitions were analyzed for evidence of the Dy(IV) species with the $4f^9$ configuration. Since Dy(IV) is isoelectronic with Tb(III), comparison of the middle and near infrared absorption spectra of the orange fluorination product against that of some Tb(III) compounds and the parent Dy(III) compound allowed identification of all of the components of the ^7F ground state multiplet for Dy(IV). Less effective screening of the nuclear charge in tetravalent dysprosium resulted in a raising of the 4f energy levels compared with isoelectronic Tb(III), as expected. The approximate centers of the six levels above the $^7F_6$ ground state were found at 2000, 4120, 5480, 6560, 7250, and 7460 cm^{-1} for J values 5, 4, 3, 2, 1, and 0, respectively. Excitation of fluorocarbon mulls of Cs_3DyF_7 at 4050 Å resulted in fluorescence at 5250 Å and a weaker line at 6300 Å. Assuming that the most intense fluorescence transition was $^5D_4 \rightarrow {}^7F_5$, analogous to Tb(III), the $^5D_4$ level of Dy(IV) was placed near 21.000 cm^{-1}, some 600 cm^{-1} above the Tb(III) $^5D_4$ level. An energy level diagram is presented comparing several unusual oxidation states of the lanthanides. (auth)

22996 (CONF-670502–, pp 271-82) CATHODOLUMINESCENCE OF RARE EARTH-ACTIVATED YTTRIUM OXIDE. Buchanan, R. A.; Wickersheim, K. A.; Weaver, J. L.; Sobon, L. E.; Anderson, E. E. (Lockheed Missiles and Space Co., Palo Alto, Calif. Lockheed Palo Alto Research Lab.).

The current interest in rare earth-activated phosphors stimulated a general survey of the cathodoluminescent properties of rare earths in yttrium oxide. Y_2O_3: Eu and Gd_2O_3: Eu are phosphors whose cathodoluminescent properties were previously reported. Their sharp line emission spectra, superior performance, and chemical stability are some of the characteristics of these materials. Relevant properties of the other rare earth activators in yttrium oxide were investigated. Those properties of special interest reported are: optimum activator concentrations for electron excitation, emission spectra from 2500 Å to 3 microns, lifetimes of principal emission lines, and efficiencies. The materials studied were in the form of powders precipitated as oxalates and fired in air to form the phosphors. These phosphor powders were loaded into a demountable electron-gun vacuum system and excited with 9-kV electrons at beam current densities of about 2.5 μ amp per cm^2. Survey spectra and lifetime studies were made using a ¼-meter Jarrell–Ash monochromator system and photomultiplier detector. Lifetimes were measured using a pulsed electron beam and ordinary photomultiplier and oscilloscope techniques. Precise wavelength measurements and photometric measurements were taken with a Cary Model 14 used as a spectrometer with MPT and PbS detectors. Several of the rare earths have most of their emission concentrated in a few closely spaced lines while others distribute their emission among several widely spaced groups of lines. Lifetimes of principal lines fall generally in the several hundred microsecond range and show a correlation with the energy gap from the emitting state to the next lowest state. (auth)

22997 (CONF-670502–, pp 283-94) PREPARATION AND PROPERTIES OF SOME FLUORESCENT RARE EARTH COMPOUNDS. Loriers, Jean (Centre National de la Recherche Scientifique, Bellevue (France); Heindl, Rudolf (Laboratoire Central de Telecommunications, Paris (France)).

The preparation and properties of some fluorescent inorganic rare earth compounds derived from the orthovanadates of general formula $YtVO_4$ (Yt = Y, Gd, Lu, or Sc) by balanced cation substitution are described. Two series of compounds are considered: double and polycationic orthovanadates with zircon structure and $ABVO_4$-type compounds. When doped with europium or other lanthanides, these compounds have fluorescent properties similar to those observed with yttrium orthovanadate as host material. The fluorescence spectra under uv excitation have some interesting properties compared with those of usual fluorescent orthovanadates. The influence on intensity of emission lines was studied with respect to changes in substitution elements and concentration of doping lanthanide. (auth)

22998 (CONF-670502–, pp 318-28) CURRENT PROBLEMS AND STUDIES IN THE COORDINATION CHEMISTRY OF THE RARE EARTH–METAL IONS. Moeller, Therald (Illinois Univ., Urbana. Noyes Lab. of Chemistry).

The problems to be considered include the structure of and bonding within complex species, thermodynamic stabilities of the complex species in solution, those properties that arise from f configurations, and the applications that depend upon specific properties of individual complexes. Structural studies support the view that coordination number six and octahedral geometry are the exception rather than the rule. Although the bonding between cation and ligand is, by general agreement, primarily electrostatic in nature, small but significant covalent contributions are indicated by spectral and other studies. Ligand field stabilization, however, is minimal. The irregularities in the thermodynamic stabilities (i.e., formation constants, free energy changes) of complexes with particular ligands as the ion Ln^{3+} is varied appear to result from combinations of various factors. Detailed evaluations of environmental effects on absorption spectra provide a better understanding both of the properties of 4f electrons and their chance of participating in bonding. The process of energy transfer through an excited chelating ligand to an appropriate rare earth ion, with the consequent emission of coherent radiation, is considered. (auth)

22999 (CONF-670502–, pp 329-40) OM_4 TETRAHEDRON LINKAGES: AN IMPORTANT FEATURE IN RARE EARTH OXIDE AND OXYSALT STRUCTURES. Caro, Paul E. (Iowa State Univ. of Science and Technology, Ames).

Rare earth oxides and oxysalt structures are considered with respect to the coordination of the oxygen atom. Metallic atoms are found to be in tetrahedral positions around the oxygen atom, and all known structures can be described as tridimensional or bidimensional packing of OM_4 tetrahedra joined together by sharing of edges. In A-M_2O_3, B-M_2O_3 structures and the oxysalts the packed tetrahedra appear as an infinite polymeric complex cation $(MO)_x^{x+}$. Possible implications for the structure of nonstoichiometric oxides are discussed. Optical studies show that the rare earth atoms in oxides are to some extent covalently bonded, and it is suggested that the oxygen atoms are involved in a directional bonding, possibly of a sp^3 type. (auth)

23000 (CONF-670502–, pp 366-73) THE PREPARATION OF THORIUM DICARBONATE, URANYL CARBONATE, AND THE SESQUICARBONATES OF La, Ce, Pr, Tb, AND Y FROM THE CORRESPONDING ANHYDROUS ACETATES. Head, E. L. (Los Alamos Scientific Lab., N. Mex.).

Two methods for the preparation of the rare earth sesquicarbonates were described previously. Those studies were continued and a method was developed for the preparation of La, Ce, Pr, Tb, and Y sesquicarbonates; thorium dicarbonate; and uranyl carbonate from their respective anhydrous acetates. Methods are described for the preparation of the various anhydrous acetates used. Typical analytical data for the compounds prepared and thermal decomposition diagrams for the thorium dicarbonate and uranyl carbonate are given. The method consistently produced carbonate product yields of about 75 to 80% for the sesquicarbonates, 90 to 95% for thorium dicarbonate, and 90 to 93% for uranyl carbonate. Use of the hydrated acetate salt in the case of La, Ce, and Pr produced carbonates much more difficult to filter and in yields of less than 50%. (auth)

23001 (CONF-670502–, pp 385-90) PRECIPITATION OF RARE EARTH OXIDES FROM MOLTEN SALTS. Brauer, Georg (Freiburg Univ. (West Germany)).

Rare earth oxides or oxide nitrates were precipitated from anhydrous rare earth nitrates dissolved in molten mixtures of alkali nitrates by self-decomposition at 400°C. La and Nd form oxide nitrates under these conditions. Ce, Pr, and Tb are precipitated as higher oxides CeO_2, $PrO_{1.83}$, and $TbO_{1.86}$, respectively. The other rare earths are precipitated as sesquioxides with the B-type structure (Sm, Eu, Gd) or with the C-type structure (Dy through Lu). Thus, the B-type modifications of Sm_2O_3, Eu_2O_3, and Gd_2O_3 must be the really stable phases at 400°C. A new version of the phase stability diagram of the A-, B-, and C-type polymorphs of the rare earth sesquioxides is proposed. (auth)

23002 (CONF-670502–, pp 392-402) ALKOXY AND ACYLOXY DERIVATIVES OF LANTHANONS. Mehrotra, R. C.; Batwara, J. M.; Misra, S. N.; Misra, T. N.; Tripathi, U. D. (Rajasthan Univ., Jaipur (India). Chemical Labs.).

The preparation and properties of rare earth alcoholates, MCl_3 3ROH, are described. The triisopropanolates serve as convenient starting materials for the synthesis of triisopropoxides, $M(OPr^i)_3$, by refluxing their solutions in isopropanol-benzene mixture with stoichiometric quantities of sodium isopropoxide. The isopropoxides can in some cases be purified by crystallization and volatilization and undergo alcoholysis reactions by which other alkoxide derivatives can be prepared. The reactions of these alkoxides particularly of isopropoxides were studied in benzene with acetyl chloride, acetyl bromide, phenols, glycols, β-diketones, and β-ketoesters. A wide variety of metalloorganic compounds including anhydrous β-diketonates of lanthanons were synthesized. The acyloxy derivatives of rare earths, $M(OOCR)_3$ (where R is $C_{11}H_{23}$, $C_{15}H_{31}$, and $C_{17}H_{35}$) were synthesized by treating their chlorides or nitrates with appropriate sodium soap solutions in water. The precipitated triacylates can be crystallized from benzene in which they depict monomeric behavior. The triacyloxides as well as chloride acyloxide derivatives were synthesized by the reactions between lanthanon chlorides and carboxylic acids in benzene solu-

tion. Preliminary thermogravimetric studies of lanthanon soaps were also carried out. (auth)

23003 (IA-1128, pp 97-146) INORGANIC AND PHYSICAL CHEMISTRY. (Israel Atomic Energy Commission, Tel Aviv).

Developments are reported for studies on: thorium tribromide; nitrate complexing of Am(III); ion-solvent interaction; improved isopiestic apparatus; extrapolation of electrolyte solution densities; thermodynamics of electrolyte solutions; properties of mixed electrolytes; solvation numbers of lanthanide ions in solution; piezo-optic coefficients of aliphatic alcohols; heats of ion exchange in dilute non-aqueous solutions; pack distillation column dynamics; distribution of solutes between liquid HF and organic solvents; ion exchange in molten salts; voltammetric determination of water in molten alkali metal nitrates; phase diagrams of $PbCl_2-UCl_4$ and $PbCl_2-UCl_3$; partition of mixed halide complexes of Hg(II) and Zn(II) between molten salt and aromatic solvent; electrodeposition from molten salts; anodic oxidation of Ta in fused nitrates; corrosion and passivity; cathodic deposition of Cr; decanning of U from various sheaths by cathodic and galvanic procedures; cathodic decontamination of metals; thermomagnetic measurements of PrF_4; production of uranium fluoride by wet process; preparation of UCl_4; preparation of silver trifluoride; electrolytic production of N_2O; reduction of Ce^{4+} by H_2O_2 and NO_2^- in aqueous nitric acid; determination of isotopic composition of hydrogen in H_2O; determination of Cs in sea water; determination of dissolved gases by gas chromatography; determination of Ga in geological materials by single addition method; determination of Fe, Mg, and Cu in used lubricating oils; spectrochemical analysis of Dead Sea water for Al. (P.C.H.)

23004 (JUL-Bibl-13) XENON PHYSIKALISCHE UND PHYSIKALISCH-CHEMISCHE EIGENSCHAFTEN. Eine Literaturzusammenstellung. (Xenon: Physical and Physical-Chemical Properties. A Literature Compilation). Gehrke, G.; Paul, E. (Kernforschungsanlage, Juelich (West Germany)). Oct. 1967. 54p. (In German and English). Dep.

The literature compilation covers the years 1947 to 1967 and contains 615 titles. The references are arranged under the headings: general, thermodynamics, transport properties, reactions of xenon with solids (accommodation coefficients), solubility of xenon in liquids, liquid xenon, solid xenon, other physical properties and effects, and occurrence and production of xenon. An author index is included. (M.C.G.)

23005 (UCLA-34-P-120-3) SPECTROSCOPIC STUDIES OF ACTINIDE IONS IN CRYSTALLINE SOLIDS. Final Report, October 1, 1964-June 30, 1966. Gruber, John B. (California Univ., Los Angeles. Dept. of Physics). Contract AT(11-1)-34. 14p. Dep. CFSTI.

Developments are reported for studies on: crystal-field splitting of trivalent thulium and erbium J levels in yttrium oxide; absorption spectrum of thulium ethyl sulfate; energy levels of single-crystal erbium oxide; optical spectra of tripositive ^{244}Cm in lanthanum trichloride; energy levels of Np^{3+} in $LaBr_3$; spectrum of gaseous UCl_4; spectrum of Nd^{3+} in lanthanide oxide crystals; and preparation and growth of single crystals of ThO_2 doped with tetravalent actinide ions. (P.C.H.)

23006 (UCRL-17996) TRACER CHEMISTRY STUDIES OF NOBELIUM. Maly, Jaromir; Sikkeland, Torbjorn; Silva, Robert; Ghiorso, Albert (California Univ., Berkeley. Lawrence Radiation Lab.). Dec. 1967. Contract W-7405-eng-48. 18p. Dep. CFSTI.

Nobelium-255, with alpha half-life of 3½ minutes, was used to study the tracer chemistry of element 102. In ion exchange and coprecipitation studies, nobelium did not exhibit the behavior expected for a member of the actinide series in the +3 valence state. Work on elution positions and solubilities of hydroxides, sulfates and fluorides suggests that the +2 oxidation state, predicted to exist in addition to the +3 state for nobelium, was the stable species in aqueous solution. Results of oxidation experiments are presented and preliminary results suggest a potential for the $No^{+2}-No^{+3}$ couple of approximately -1 volt. (auth)

23007 (UJV-1832) VYPAROVANI AKTINIDU A JEJICH SLOUCENIN. IV. VYPAROVANI NEKTERYCH SLOUCENIN NEPTUNIA A PLUTONIA. (Vaporization of Actinides and Their Binary Compounds. IV. Vaporization of Binary Neptunium and Plutonium Compounds). Krivy, I. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). June 1967. 19p. (In Czech). Dep.

Studies were made on the vaporization of some binary compounds of neptunium and plutonium. It involves the survey and the critical treatment of available papers in the field up to 1st June 1966, with special attention given to the compounds of interest in nuclear reactor technology, namely PuO_2 and PuC_2. For each two-component system discussed there is a separate chapter presenting these fundamental data: the list of the binary compounds with their crystal structures, the composition of the vapour over the condensed phases (at least qualitatively) together with the dependence on the experimental conditions, and last, the results of tensimetric experiments usually given in the form log P = f(T). The values of dissociation energy for the gaseous species or eventually those of standard free energy of formation for the individual condensed phase (ΔG_T^0) are presented provided that they are derived on the basis of tensimetric data. (auth)

23008 AMMONIUM HEXACHLOROOSMATE; A SUITABLE COMPOUND FOR NUCLEAR PHYSICS EXPERIMENTS CONCERNING OSMIUM NUCLEUS. Kemeny, P. (Inst. of Atomic Physics, Bucharest). Rev. Roum. Phys., 12: 761-4(1967).

Ammonium hexachloroosmate, $(NH_4)_2[OsCl_6]$, was prepared and its properties studied. It was found to be safer for experimental uses than osmic acid. The complex was neutron-irradiated in order to study its radiochemical purity and crystal structure, which were found to meet the requirements of angular correlation measurements. (J.G.B.)

23009 ISOTOPIC EXCHANGE REACTIONS OF CARBON COMPOUNDS. THE SYNTHESIS OF UREA-^{14}C. Falecki, J. (Inst. of Nuclear Research, Swierk, Poland). Bull. Acad. Pol. Sci., Ser. Sci. Chim., 16: 35-7(1968).

An isotopic exchange that was found to occur between $CO_2-^{14}C$ and urea was used for the preparation of carbon-14-labeled urea. The exchange was carried out on a millimole scale and yielded a product of a relatively high purity. The optimum conditions for the exchange between $CO_2-^{14}C$ and urea are given. (P.C.H.)

23010 APPLICATION OF A ^{239}Pu ELECTRODE FOR THE DETERMINATION OF THE SOLVATION ENERGY OF URANYL SALTS IN AQUEOUS AND BUTYLPHOSPHATE SYSTEMS. Kamienski, B.; Kulawik, I.; Kulawik, J.; Mikulski, J.; Pawelek, J. (Inst. of Physical Chem., Krakow. Jagellonian Univ., Krakow. Inst. of Nuclear Physics, Krakow). Bull. Acad. Pol. Sci., Ser. Sci. Chim., 16: 57-61(1968).

Studies were made on the interface between the butyl phosphate and the aqueous solutions of uranyl salts at equilibrium. These measurements were used to study the extraction and mechanism of passing of uranyl salts across the oil-water interface. From these potential differences the distribution coefficients and solvation energies of the salts in the organic phase were calculated. The results showed that the electric interface potential does not depend on the change of concentration of UO_2Cl_2 in the system $Hg/Hg_2Cl_2/1\ N$ KCl/aqueous UO_2Cl_2/TBP. The thermodynamic distribution coefficient for the H_2O-TBP system can be calculated from the measurements of electric interfacial potentials; it equals 0.036. On the basis of the results, it was affirmed that the solvation energy of UO_2Cl_2 in water saturated with TBP is by about 3.9 kcal/mole lower than the hydration energy. (P.C.H.)

23011 VOLUME CHANGES ON MIXING SOLUTIONS OF ALKALI HALIDES AND SYMMETRICAL TETRAALKYLAMMONIUM HALIDES. II. EFFECTS OF DEUTERIUM OXIDE AND TEMPERATURE. Wen, Wen-yang; Nara, Kenichi (Clark Univ., Worcester, Mass.). J. Phys. Chem., 72: 1137-9(Apr. 1968).

Volume changes on mixing aqueous solutions of potassium bromide and some tetraalkylammonium bromides were measured at constant total ionic strength in D_2O at 25°C and in H_2O at 15 and 25°C. In addition, the volume changes on mixing solutions of Pr_4NBr and CsBr, as well as Pr_4NBr and Me_4NBr, were determined at 25°C. The results are explicable in terms of the solvent structural changes induced by the ion-ion and ion-solvent interaction. (auth)

23012 VAPOR PRESSURES OF THE ISOTOPIC WATERS AND ICES. Van Hook, W. Alexander (Univ. of Tennessee, Knoxville). J. Phys. Chem., 72: 1234-44(Apr. 1968).

A detailed application of the theory of isotope effects in condensed systems is made to the various D, T, ^{17}O, and ^{18}O vapor pressure isotope effects (VPIE) for liquid and solid water between 230 and 400°K. Force fields for the liquid and solid are developed which quantitatively correlate the VPIE's for the 18 different isotopic isomers of water over this temperature range. The general precision of the agreement between calculated and observed results (where available) is excellent. Some limitations on the calculation are pointed out. Finally, nonideality in H_2O, HDO, and D_2O solutions is discussed. (auth)

23013 DIFFUSE TRANSITION AND MELTING IN FLUORITE AND ANTI-FLUORITE TYPE OF COMPOUNDS: HEAT CONTENT OF POTASSIUM SULFIDE FROM 298 TO 1260°K. Dworkin, A. S.; Bredig, M. A. (Oak Ridge National Lab., Tenn.). Contract W-7405-eng-26. J. Phys. Chem., 72: 1277-81(Apr. 1968).

The heat content and entropy of K_2S from 298 to 1260°K were measured by means of a copper block drop calorimeter. K_2S was found to have the low entropy of fusion of 3.16 eu $mole^{-1}$, similar to those in CaF_2 and $SrCl_2$ with which it is anti-isotypic. As in these latter crystals, this is connected with the occurrence of a diffuse transition, with a heat capacity maximum of 45 cal deg^{-1} $mole^{-1}$ at about 780°K but extending from about 550°K to the melting point at 948°K and involving an entropy change of 4 eu $mole^{-1}$. It is suggested that the occurrence of a diffuse transition is a general characteristic of the substances AB_2 of fluorite and antifluorite types of crystal structure. It is attributable to the gradual distribution of the B ions, with rising temperature, over both the octahedrally and tetrahedrally coordinated lattice positions. This leads to the high rate of diffusion and electrical mobility of the B ions. Heat content data found in the literature for such fluorite type crystals as UO_2, ThO_2, and Na_2O indicate that diffuse transitions also occur in these compounds although more information is needed in these cases. (auth)

23014 CLASSICAL ISOTOPE EFFECT IN VIBRATIONAL RELAXATION: THE RELAXATION OF H_2 AND D_2. Kiefer, John H. (Univ. of Illinois, Chicago). J. Chem. Phys., 48: 2332-7(Mar. 1, 1968).

A general classical analysis of the effect of uniform mass scaling on vibrational relaxation is given which shows that the thermal rate of excitation of a system from an initially vibrationless state varies inversely as the square root of the mass ratio. This accurate classical result affords an unambiguous comparison of the augmented classical methods with measurements of relaxation in H_2 and D_2. The Parker formulation of the relaxation time alone does not produce the observed isotope effect, but close agreement does result when this method is symmetrized. Consideration of the high-temperature behavior of the ratio τ_{D_2}/τ_{H_2} shows that the deviations from the Landau–Teller temperature dependence found by Kiefer and Lutz are simply a property of the normal relaxation process, and not a consequence of relaxation-dissociation coupling. (auth)

23015 NEUTRON DIFFRACTION STUDY OF CESIUM URANYL NITRATE. Zivadinovic, Milutin S. Bull. Boris Kidric Inst. Nucl. Sci., 18: 405-12(Oct. 1967).

The crystal structure of cesium uranyl nitrate, $CsUO_2(NO_3)_3$, was determined from neutron diffraction intensities of (HO·L) and (HK·L) reflections of the hexagonal cell by the Fourier synthesis and minimum residual methods. The uranium atom is surrounded by eight oxygen atoms at the corners of an irregular hexagonal bipyramid, six nitrate group oxygen atoms at 2.52 Å and two uranyl oxygen atoms at 1.77 Å. The hexagon of six oxygen atoms surrounding the uranyl ion on the equator is slightly puckered and thus the nitrate groups are not coplanar with the plane (00.1). (auth)

23016 DISSOCIATIVE ELECTRON ATTACHMENT TO HYDROGEN HALIDES AND THEIR DEUTERATED ANALOGS. Christophorou, L. G.; Compton, R. N.; Dickson, H. W. (Oak Ridge National Lab., Tenn.). Contract W-7405-eng-26. J. Chem. Phys., 48: 1949-55(Mar. 1, 1968). (ORNL-P-3491).

The swarm-beam technique was employed to study the electron-attachment processes in HX and DX (X = halogen) molecules. Attachment cross sections as a function of electron energy $\sigma_c(\epsilon)$, corrected for the finite width of the electron beam, are reported for the direct dissociative attachment, i.e., HX (or DX) + e → H (or D) + X^-. There is a strong increase in $\sigma_c(\epsilon)$ in going from HCl to HBr to HI, i.e., with decreasing energy of the dissociative-attachment peak. The ratio of $\sigma_c(\epsilon)$ for isotopic species was found to be very nearly equal to the square root of the inverse ratio of the reduced masses of the products. In addition to the direct dissociative electron attachment to HX and DX molecules, a separate attachment process occurred at thermal electron energies. (auth)

23017 MATRIX-ISOLATION STUDY OF THE REACTION OF ATOMIC AND MOLECULAR FLUORINE WITH CARBON ATOMS. THE INFRARED SPECTRA OF NORMAL AND ^{13}C-SUBSTITUTED CF_2 AND CF_3. Milligan, Dolphus E.; Jacox, Marilyn E. (National Bureau of Standards, Washington, D. C.). J. Chem. Phys., 48: 2265-71(Mar. 1, 1968).

Carbon atoms, resulting from the photolysis of cyanogen azide, were found to react with molecular fluorine in an argon matrix at 14°K to produce CF_2. The use of ^{13}C led to confirmation of the previous assignment of features at 1073 and 1191 cm^{-1} to $^{13}CF_2$ present in natural abundance. Using recent structural data on CF_2 and the $^{12}CF_2$ and $^{13}CF_2$ frequencies, it was possible to calculate the complete valence force potential of CF_2. Values of the potential constants were compared with those of the related species NF_2 and OF_2. When the sample was subjected to radiation of wavelengths effective in photolyzing F_2, CF_3 was also produced. Sufficient yields of both $^{12}CF_3$ and $^{13}CF_3$ were obtained for observation of all four vibrational fundamentals. Data were fitted to a four-constant valence force potential. Agreement was most satisfactory for a C_{3v} structure with a deviation of 13° from planarity. Using this structure, the thermodynamic properties of CF_3 were estimated. (auth)

23018 ABSORPTION SPECTRA OF MOLECULES H_2, HD, AND D_2. VII. VIBRATIONAL CONSTANTS OF THE B, B', B'', C, D, D', AND D'' STATES. Monfils, A. (Institut d'Astrophysique, Cointe-Sclessin, Belgium). J. Mol. Spectrosc., 25: 513-43 (Apr. 1968).

Vibrational constants of seven singlet states of H_2, HD, and D_2 were computed by means of spectroscopic data obtained from absorption spectra. The method used was least squares analysis; its meaning for the determination of vibrational constants was examined and criteria for the choice of physically meaningful solutions given. The constants obtained were compared with each other; extrapolated values for ω_e and $\omega_e X_e$ were found for H_2^+. The ν_e, T_e values and dissociation energies were calculated for each state. In the case of the dissociation energies, the various corrections involved are discussed. The data obtained are compared with those published in the literature. (auth)

23019 APPLICATION OF ISOTOPES IN ORGANIC CHEMISTRY. Schutte, L. (Univ. of Leyden, Netherlands). RCN (Reactor Cent. Ned.) Meded., No. 29, 91-108(1967). (In Dutch).

Tracer techniques can be used to detect and analyze reaction products and to investigate reaction mechanisms and molecular structures. Such work is based on the assumption that two isotopes behave identically chemically. On the other hand the mass difference between two isotopes may lead to a small difference in chemical behavior. This isotope effect often gives a decisive answer on a reaction mechanism. (tr-auth)

23020 THE MANGANESE, COBALT, NICKEL, COPPER, SILVER, AND MERCURY URANATES. Jakes, D.; Sedlakova, L. N.; Moravec, J.; Germanic, J. (Inst. of Nuclear Research, Prague). J. Inorg. Nucl. Chem., 30: 525-33(Feb. 1968).

Monouranates of cobalt, manganese, silver, and mercury, and triuranates of cobalt, manganese, nickel and copper were prepared from pressed mixtures of oxides or carbonates and nitrates. The ir spectra of all unique x-ray phases were measured. The influence of oxygen vapour pressure on the ir spectra, and the problem of phase purity of the product, are discussed. (auth) (UK)

23021 CHEMISTRY OF TRANSURANIUM ELEMENTS. Kraak, W. RCN (Reactor Cent. Ned.) Meded., No. 29, 53-74 (1967). (In Dutch).

The chemistry of the transuranium elements is surveyed on the basis of their systematics. Microanalysis and separation techniques applied to identify isotopes of these elements are discussed. Determination of their chemical and physical properties from very small quantities of the materials is also mentioned. (tr-auth)

23022 KINETICS OF THE SORPTION OF RARE EARTH ELEMENTS IN THE PRESENCE OF POLYAMINO-POLYCARBOXYLIC ACIDS. Matorina, N. N.; Shepetyuk, L. V.; Chmutov, K. V. (Inst. of Physical Chemistry, Moscow). Zh. Fiz. Khim., 41: 2345-7 (1967). (In Russian).

A study was made of the sorption and desorption of rare earth elements from solutions containing diethylenetriaminepentacetic acid and EDTA. Volume of solution was 25 to 40 ml, weighed portion of cationite was 0.16 to 1 g, and a propeller-type agitator with a speed of 750 to 1500 rpm was used. The radioactive isotopes used were ^{144}Ce, ^{144}Pr, and $^{152,154}Eu$. The initial concentration of rare earth elements in the external solution was 10^{-4}N. Calculations were made using the expression $\{Q/Q_\infty = (1 - \Delta q/q)\ [1 - 6/\pi^2\ \Sigma_{n=1}^{\infty} \exp(-D\pi^2 n^2 t)/r^2)]\}$ without taking into account the term $1-(\Delta\ q/q)$, where Q is the total amount of absorbed cation at moment of time t; Q_∞ is the total amount of cation penetrating into the particle through a unit of area in time t; Δ q is the amount of sorbed component bound within the particle in a negatively charged complex and diffusing up to the moment of time t from the cationite particle into the solution; r is the radius of a particle of cationite. Experimental results show that with a decrease in the concentration of H^+ ions in the ionite, the internal diffusion coefficients decrease, attain a minimum, and then rise to the values obtained in the absence of complex formation. (ATD)

23023 CATALYTIC REDUCTION OF SOLUTIONS CONTAINING URANIUM(VI) BY MEANS OF FORMIC ACID. Zanelli, Severino (CNEN, Rome. Univ., Pisa, Italy). Ing. Nucl., 8: No. 5, 23-7(Sept.-Oct. 1967). (In Italian).

The reaction for the reduction of hexavalent to tetravalent uranium in nitrate solution by means of formic acid, for concentra-

tions of uranium less than 0.1M and of formic acid greater than 0.4M, belongs to the first order with respect to uranium and to the zero order with respect to formic acid. The velocity of the decomposition of the formic acid into hydrogen and carbon dioxide by means of a catalyst depends only on the phenomenon of surface adsorption. Temperature has an appreciable effect on the velocity of the reaction. (tr-auth)

23024 PREPARATION OF SAMARIUM HEXABORIDE. Bondarenko, V. P.; Vereshchak, S. S. (Kiev Polytechnic Inst.). Izv. Vyssh. Ucheb. Zaved., Khim. Khim. Tekhnol., 11: 124-6(1968). (In Russian).

The influence of temperature on the thermal reaction of boron with samarium oxide was investigated. Pure preparations of SmB_6 were obtained at 1650 ± 50°C using a Moissan amorphous boron (in 1 hr reaction). The first stage of the reaction at a temperature up to 1200°C produced samarium hexaboride and B_2O_3; and the next stage, in which the B_2O_3 reacted with excess boron, resulted in separation of B_2O_3. The high K values are the result of the high volatility of oxide and metallic samarium and low volatility of the SmB_6. The lattice parameter of SmB_6 is 4.13 Å. (tr-auth)

23025 USE OF THE GLASS ELECTRODE IN DEUTERIUM OXIDE AND THE RELATION BETWEEN THE STANDARDIZED pD (pa_D) SCALE AND THE OPERATIONAL pH IN HEAVY WATER. Covington, A. K.; Paabo, Maya; Robinson, R. A.; Bates, Roger G. (National Bureau of Standards, Washington, D. C.). Anal. Chem., 40: 700-6(Apr. 1968).

Commercial glass electrodes were compared both directly and indirectly with the deuterium gas electrode at 25°C in buffered solutions of pD from 1 to 13. It was confirmed that the glass electrode functions as well in heavy water as in ordinary water. The relation between the operational pH of a buffer solution in heavy water (obtained with a glass electrode standardized in an ordinary water buffer solution) and its pD or pad value obtained from measurements on cells without liquid junction was examined and correction factors determined for both glass and gas electrodes. The operational pH of buffer solutions in heavy water at 25°C, measured with the glass electrode, can be converted into a pD value by adding 0.41 (molar scale) or 0.45 (molal scale) for $2 < pD < 9$. (auth)

23026 MASS AND ABUNDANCE DATA FOR POLYISOTOPIC ELEMENTS. Carrick, A.; Glockling, F. (Univ. of Durham, Eng.). J. Chem. Soc., A, No. 1, 40-2(1967).

Mass and abundance data for ions derived from organo-derivatives of polyisotopic elements were calculated and compared with experimental values. The method of calculation deals with ions containing up to three different elements (a, b, c) within the range $a_{1\to4}$ $b_{0\to6}$ $c_{0\to5}$, and corrects for the heavy isotopes of C, H, N, and O. (auth) (UK)

23027 THE REACTIONS OF ACTIVATED AMIDES. PART II. A NEW SYNTHETIC ROUTE TO ββ-DISUBSTITUTED INDOLINE DERIVATIVES. Oishi, T.; Nagai, M.; Ban, Y. (Hokkaido Univ., Sapporo). Tetrahedron Lett., No. 4, 491-5(Jan. 1968).

The kinetic isotope effects of the sulfonylation of benzene and benzene-d_6 with the p-toluenesulfonyl chloride–aluminum chloride complex in methylene chloride were calculated to be k_H/k_D = 2.44 ± 0.3 (0.0°C); 1.91 ± 0.3 (7.0°C); and 2.09 ± 0.3 (15.5°C). Preliminary studies for the sulfonylation of bromobenzene and bromobenzene-4d also showed primary hydrogen isotope effects. The value of k_H/k_D was found to be 1.77 ± 0.2 at 0.0°C. (D.H.M.)

23028 IMPROVEMENTS IN OR RELATING TO URANIUM DIOXIDE-CONTAINING AQUASOLS. (to W. R. Grace and Co.). British Patent 1,108,316. Apr. 3, 1968. Priority date Aug. 18, 1964, United States.

A process for the preparation of a UO_2 aquasol comprises heating at 80 to 120°C until peptization occurs a mixture having a pH of 1.5 to 4.0 of hydrous, alkaline-precipitated electrolyte-free UO_2 and an aqueous solution of an acidifying agent. The same procedure may be used to prepare a UO_2–ZrO_2 aquasol by peptizing a mixture having a pH of 0.5 to 4.0 of hydrous, alkaline-coprecipitated electrolyte-free UO_2–ZrO_2 containing from 1 to 80 mole % ZrO_2 and an aqueous solution of an acidifying agent. (B.L.M.)

23029 METHOD FOR PRODUCTION OF DEUTERATED METHANES AND HEAVY WATER. Pogorski, Louis August (to British American Oil Co., Ltd.). British Patent 1,107,522. Mar. 27, 1968. Filed June 2, 1965.

Because of the difference in vapor pressures of deuterated and nondeuterated methanes, it is possible to recover deuterated methane from a mixture of these by subjecting the mixture to low-temperature fractionation and separating a fraction enriched with the deuterated methane. Oxidation of this enriched fraction with air or O_2 yields a mixture containing deuterium oxides, hydrogen oxides, and carbon oxides. (B.L.M.)

23030 AQUASOLS CONTAINING HAFNIA OR ZIRCONIA. (to W. R. Grace and Co.). British Patent 1,110,040. Apr. 18, 1968. Priority date Sept. 23, 1964, United States.

An aquasol of hafnia, zirconia, or mixtures of these can be prepared by replacing anions from an aqueous solution of a basic salt of Hf or Zr or both for a time sufficient for the specific conductance of the dispersion to become substantially constant. The anions can be removed by either electrodialysis or use of an anion exchange resin in the hydroxyl form in a solution maintained at a temperature of 50 to 70°C. The aquasols so produced have a particle size of from 3 to 10 mμ and contain less than 30% solids. (B.L.M.)

23031 IMPROVEMENTS RELATING TO THE IONIZATION OF GASES. (to Kaman Aircraft Corp.). British Patent 1,108,997. Apr. 10, 1968. Priority date Oct. 16, 1964, United States.

A gas ionizer for ionizing a gas without the use of a magnetic field comprises a first metal electrode providing a wall portion embracing a space and a second rod-shaped metal electrode positioned eccentrically in the space. The cross-sectional area of the second electrode is very much smaller than the cross-sectional area of the space. An environment of the gas is provided in the space at very low pressure. The pressure of the gas used and the dimensions of the wall portion of the first electrode is such that the ionization mean free path of 100-eV electrons in the gas is greater than the largest inside cross-sectional diameter of the space. The electrodes can be connected to biasing means for biasing one of the electrodes negatively with respect to the other to a voltage higher than the starting potential of ion discharge. Urging means are provided for moving the electrodes inwardly into the space. The length of the second electrode is less than twice the length of the space along the wall portion embracing the space, and the second electrode is spaced from the wall portion throughout at least ⅔ of its length by a distance substantially greater than the cross-sectional diameter of the second electrode. (B.L.M.)

Radiation and Nuclear Chemistry

Refer also to abstracts 22944, 22947, 23271, 23409, 23691, 23692, 24488, and 24860.

23032 (AECL-2706, pp 29-49) ELECTRON MICROSCOPIC OBSERVATIONS ON CELLULOSE GRAFT COPOLYMERS: RADIATION INDUCED RAYON-STYRENE GRAFT COPOLYMERS. Kaeppner, Werner M.; Huang, Robert Y-M.

Published in Text. Res. J., 35: No. 6, (June 1965).

Three types of commercial rayon (Fortisan, high-tenacity tire yarn, and modifier-type, high wet modulus yarn) were grafted with styrene, using the direct radiation method with gamma rays from ^{60}Co. The grafted filaments were examined in the electron microscope to investigate their morphology and fine structure, the location and distribution of polystyrene in the fiber, and whether the polystyrene was truly grafted. In all three grafted fibers, the polystyrene was distributed throughout the cross section of the filament and also appeared on the surface. As a result, the filaments expanded isometrically during grafting, but retained their original shape. The polystyrene grafted to the surface of the filament followed the original surface striations of the rayon and appeared as protruding ridges and valleys, rather than as uniform surface layers. The polystyrene inside the filament could not be removed by exhaustive extraction of the intact yarn with benzene, but some of it could be removed by extracting the ultrathin cross sections (ca. 500 Å thick) used for electron miscroscopic observations. The main portion of these ultrathin sections was insoluble in solvents for both polystyrene and cellulose and is considered to be a true cellulose-styrene graft. The changes induced in the fine structure of the cross sections by alternate extraction with solvents for polystyrene and cellulose were followed, using the electron microscope. From a macroscopic viewpoint, it was concluded that the styrene-grafted rayons are homogeneous. At a molecular level, however, they consist of a gross heterogeneous mixture of polystyrene homopolymer, cellulose, and true cellulose-styrene graft copolymer. (auth)

23033 (BNL-12334) USE OF GAMMA RADIATION TO INITIATE POLYMERIZATION REACTIONS. Kukacka, L. E.; Colombo, P.; Steinberg, M. (Brookhaven National Lab., Upton, N. Y.). Mar. 1968. 20p. Dep. CFSTI.

A study on the radioinduced polymerization of ethylene is reported. Kinetic data and polymer properties were obtained from a series of capsule and "fall-through" type experiments.

Preliminary cost estimates, based on these data, indicate potential commercial interest. A small-scale flow experiment is being operated to verify these data and to obtain larger quantities of polymer for further product characterization. (auth)

23034 (IA-1128, pp 78-96) RADIATION CHEMISTRY. (Israel Atomic Energy Commission, Tel Aviv).

Developments are reported for studies on: radiolysis of Tl_2SO_4, aqueous TlCl, and concentrated nitrate ion solutions; activation energies of reactions of hydrated electrons; linear energy transfer effect in $G_{e^-_{aq}}/G_H$; reactions of fluoride ions with hydrogen atoms in aqueous solutions; reactions of haloaliphatic acids with free radicals in aqueous solutions; effects of alkali salts on G(-thymine); gamma radiolysis of hexane-perfluoroalkene solutions; yields of scavengeable hydrogen atoms, electrons, and positive charges in the radiolysis of liquid hexane; mechanism for formation of HCl and $C_7H_{11}Cl_3$ in radiolysis and photolysis of solutions of tetrachloroethylene in pentane; mechanism of reduction in radiolytic hydrogen yield in dilute solutions of tetrachloroethylene in pentane; radiation chemistry of solutions of chloromethanes in cyclohexane; and radiolysis and photolysis of alkaline solutions of nitrous oxide in aliphatic alcohols. (P.C.H.)

23035 (MLM-1457) CURIE LEVELS AND ROENTGEN RATES FOR NEUTRON IRRADIATED ELEMENTS. Craft, B. D.; Rook, H. L.; Bentz, L. L. (Mound Lab., Miamisburg, Ohio). Aug. 1966. Contract AT(33-1)-Gen-53. 18p. Dep. CFSTI.

The Curie levels and Roentgen rates for one gram of an element irradiated by a reactor with a thermal neutron flux of 1×10^{13} $n/cm^2/sec$ are presented in tabulated form. The levels in milliroentgens per hour per gram of element were calculated for 1-, 10-, 100-, and 1000-min irradiation time intervals. The concentration levels (millicuries) per gram of element were calculated for the same time intervals. These values are given for some stable isotopes (prior to irradiation) of all the elements in the periodic table from lithium (atomic number 7) to bismuth (atomic number 83). (auth)

23036 (TID-24281) RADIATION INDUCED EMULSION POLYMERIZATION. Final Report, February 1, 1964-March 31, 1967. Stannett, V.; Gervasi, J. A.; Kearney, J. J.; Araki, K. (Research Triangle Inst., Durham, N. C. Camille Dreyfus Lab.). Dec. 1, 1967. Contract AT(40-1)-2513. 73p. Dep. CFSTI.

Studies were made of the γ-induced emulsion polymerization of styrene and comparisons made with chemically initiated emulsion polymerization. The polymerization proceeded smoothly to high conversions at 0 and 60°C, the reaction showing a high G(-monomer) value. Complete conversions were obtained with total doses of less than 0.05 MRAD. In accordance with the behavior expected of systems having a constant rate of initiation, the molecular weight was found to decrease with decreasing temperature. The molecular weight and particle size distributions were narrower than those obtained in chemically initiated emulsion polymerizations at the same temperature. The influence of additives was investigated in the emulsion polymerization of isoprene and butadiene. Only rhodium chloride influenced the structure of the polymer. The concentration which resulted in a significant structural change was considerably smaller than was necessary to initiate the polymerization of the dienes in the absence of radiation. The radioinduced emulsion polymerization of vinyl acetate proceeded smoothly at temperatures in the range 0 to 50°C to give polymers of much higher molecular weight than those obtained from chemically initiated polymerization at the same temperature. Complete conversion was attained after a dose of 0.02 MRAD for lattices approaching 50% solids. The elimination of ionic end groups in the polyvinyl acetate radicals tended to drive the polymerization from the aqueous phase resulting in faster rates and higher molecular weights than were obtained from chemically initiated systems. Rates of polymerization were found to be independent of temperature, and the molecular weight of the polymer to be independent of dose rate. High solids content lattices of polyvinyl acetate were evaluated for latex and film properties and found to have improvements over commercially available samples in both areas, especially in clarity of film and scrub resistance. A number of acrylate and maleate esters were copolymerized with vinyl acetate in a radioinitiated emulsion system. High molecular weight copolymers were produced after low dose. (auth)

23037 (AD-660408) EXCITED PARTICLES AND THEIR ROLE IN ELEMENTARY PROCESSES OF RADIATION CHEMISTRY AND PLASMA CHEMISTRY. Tunitskii, N. N.; Kupriyanov, S. E. Translated from paper presented at Mezhdunarodnyi Simpozium po Svoistvam i Primeneniyu Nizkotemperaturnoi Plazmy pri XX. Mezhdunarodnom Kongresse po Teoreticheskoi i Prikladnoi Khimii, Moscow, 1965. 16p. (FTD-MT-65-541). CFSTI.

The value of the excitation energy of some ions at the moment of impact was measured by determination of the impulse transferred to the atom or molecule. In order to determine the excitation energy of particles at the time 10^{-6} sec after the ionization, the method of the second impact was used. The atoms and ions of noble gases, hydrogen molecules, oxygen molecules, and others in long-lived highly excited states were detected by means of this method. These excited particles are in states closed to ionization. The reactions of excited and unexcited atoms and molecules were studied. It is shown that some products (H_3^+, HeH^+) formerly treated as resulting exclusively from ion-molecule reactions are also formed in reactions between neutral particles. The influence of vibrational excitation on ion-molecule reactions of the formation H_3^+ was investigated. (auth)

23038 (KFK-tr-239) DIE STRAHLENCHEMISCHE ADDITION VON CHLOROFORM AN OLEFINE. (The Radiation-Chemical Addition of Chloroform to an Olefin). Zagorets, P. A.; Zakhariev, A. I.; Beer, A. A. Translated into German by Peter Buriks (Kernforschungszentrum, Karlsruhe, Ger.), from Khim. Vys. Energ., 1: 36-9(1967). 12p. (In German). Dep. JCL $1.60 fs, $0.80 mf.

It was established that 1-heptene, 2-heptene, and 3-heptene are capable of participating in radiation-chemical addition to chloroform. The reaction probability follows the series 1-heptene > 2-heptene > 3-heptene. In the reactions investigated, an allyl breakage of the kinetic chain is most probable. In addition to the corresponding trichloroalkanes, dichloro- and monochloro-derivatives are also formed in the radiation-chemical additions. The amounts of these derivatives depend on the reaction probability of the olefin. (tr-auth)

23039 CHEMICAL TRANSFORMATIONS IN CARRIER-FREE ^{131}I PREPARATIONS. Nagy, G. Agnes. Magy. Kem. Foly., 74: 84-7(Feb. 1968). (In Hungarian).

The chemical transformations occurring in carrier-free $^{131}IO_3^-$ solutions prepared by anodic oxidation, observed by the paper electrophoretic technique, are reported. On standing, the carrier-free solutions were reduced to iodide. This reduction product had a saturation value that depended on the age, the pH, and the specific activity (mCi/ml) of solution. The reduction to iodide is thought to be caused by the radiolytic products of water radiolyzed by the radioactive iodine. This assumption was confirmed by the results obtained by irradiating the solutions with an external gamma source. (auth)

23040 ELECTRON SPIN RESONANCE STUDIES ON RADIATION-INDUCED POLYMERIZATION OF ETHYLENE AND ISOBUTENE ON SILICA GEL. Edlund, Ove; Kinell, Per-Olof; Lund, Anders; Shimizu, Akira (Swedish Research Council, Studsvik, Sweden). J. Polym. Sci., Part B, 6: 133-5(Feb. 1968).

Small amounts of ethylene or 2-methylpropene were added to silica gel, and the samples were γ irradiated at 77°K. ESR studies indicated the direct ionization of ethylene and 2-methylpropene. The cation radical formed apparently initiates the subsequent polymerization of ethylene and 2-methylpropene. (J.G.B.)

23041 PROSPECTS FOR THE PRODUCTION AND USES OF POLYMER WOOD IN EUROPE. Burmester, A. (Bundesanstalt fuer Materialpruefung, Berlin). Kerntechnik, 10: 79-82(Feb. 1968). (In English and German).

A list is given of the monomers studied to date for making polymer wood. The basic principles of the manufacturing process, involving impregnation and irradiation, are discussed. The physical and mechanical properties of this combined wood-plastic product are reviewed. The possible fields of use for a material with these properties, and the prospects for the future production volumes in Europe, are discussed. (auth)

23042 NUCLEAR TECHNIQUES IN THE FIELD OF TEXTILE RESEARCH AND THE TEXTILE INDUSTRY. Born, H.-J.; Lorenzen, K. (Technische Hochschule, Munich). Kerntechnik, 10: 83-5(Feb. 1968). (In English and German).

After a brief survey of nuclear methods and their general significance for technical purposes, several examples are discussed showing the application of these methods in textile industries. These examples concern processes and reactions, i.e., chemical phenomena in a broad field, and analytical applications. Radiometric methods, as the measurement of thickness or density, are not presented. As regards economy, the use of radiation energy to improve the quality of products is the most promising in the near future. (auth)

23043 SEPARATION OF CARRIER FREE ^{155}Eu FROM SAMARIUM OXIDE. Pankratova, L. N. Radiokhimiya, 10: 122-3(1968). (In Russian).

Carrier-free ^{155}Eu was prepared. The separation of ^{155}Eu from

samarium oxide was achieved by electrolysis using a mercury cathode. By maintaining the electrolyte at pH = 12 it was possible to separate 85 to 90% of the europium. (R.V.J.)

23044 KINETICS OF RARE GAS RELEASE FROM HYDROQUINONE CLATHRATES. Lindquist, K. O.; Diethorn, W. S. (Pennsylvania State Univ., University Park). Int. J. Appl. Radiat. Isotop., 19: 333-44(Apr. 1968).

The release is controlled by sublimation of hydroquinone when experimental conditions permit this process. A release model based on time-dependent sublimation from a distribution of clathrate particles fits experimental data well. In the absence of sublimation the evidence indicates that the kinetics of the $\beta \rightarrow \alpha$ transition control gas release. Radiation doses as low as 10^5 Rads significantly reduce gas release, and this beneficial effect provides a practical method of preparing clathrate of the very best quality. (auth) (UK)

23045 PRODUCTION OF ^{123}I FOR MEDICAL APPLICATIONS. Hupf, H. B.; Eldridge, J. S.; Beaver, J. E. (Oak Ridge National Lab., Tenn.). Int. J. Appl. Radiat. Isotop., 19: 345-51(Apr. 1968).

Iodine-123 at a radiochemical purity level suitable for medical diagnostic application was prepared in the ORNL 86-inch cyclotron by proton bombardment of isotopically enriched to ~80% ^{123}Te, providing hundred-millicurie amounts of ^{123}I in a few hours, with less than 1% each of ^{124}I (4.2 d) and ^{126}I (13 d). The iodine product was separated by distillation from a sulfuric acid solution, and the tellurium recovered for re-use. Target configuration, chemistry, gamma-ray spectrometry for ^{123}I, and production yields are described. The ^{123}I half-life measurements showed a value of 13.02 ± 0.02 hr. Use of ^{123m}Te ($T_{\frac{1}{2}}$ = 104 d) as a convenient long-lived substitute assay standard is described. (auth) (UK)

23046 RADIOLYTIC FORMATION AND DECOMPOSITION OF OZONE. Sears, John T.; Sutherland, James W. (Brookhaven National Lab., Upton, N. Y.). J. Phys. Chem., 72: 1166-71 (Apr. 1968).

The formation of ozone from gaseous oxygen on irradiation with ^{60}Co γ rays was investigated for various dose rates, I, ranging from 7×10^3 to 8×10^6 Rads/hr. Yield-dose curves at ambient temperature (≈10°C) and 665 torr were measured until a steady-state ozone concentration was reached. $G(O_3)$ at low doses was independent of I. Ozone concentrations of 2000 ppM at ambient temperatures and 7000 ppM at 195°K were detected. In the gas phase at 77°K, a differential $G(O_3)$ of 10.5 ± 0.5 was found. The concentration at steady state was determined by a separate back reaction(s) that destroyed ozone and by the forward rate of formation of ozone from its precursors. Different dose-rate effects were found under various conditions. The relation, $[O_3]_{ss} \propto I^{0.45 \pm 0.05}$, was determined for the steady-state yield in all-glass vessels, while $[O_3]_{ss} \propto I^{0.81 \pm 0.04}$ held when the irradiation vessel was fitted with a fluorocarbon-lubricated stopcock. Both non-radiolytic and radiolytic decomposition of ozone were also investigated. (auth)

23047 ESTIMATION OF BOND DISSOCIATION ENERGIES OF N–H BONDS BY CORRELATION WITH HT YIELDS FROM RECOIL TRITIUM ABSTRACTION. Tominaga, T.; Rowland, F. S. (Univ. of California, Irvine). Contract AT(11-1)-34. J. Phys. Chem., 72: 1399-1400(Apr. 1968).

The reactions of energetic tritium atoms with compounds containing N–H bonds were investigated, and excellent correlation of the yield of HT with the known bond dissociation energies was observed. Graphic and tabular data for the relative yields from C–H and N–H bonds in various compounds in recoil tritium reactions are given. It was concluded that the mechanism of abstraction was quite similar from both C–H and N–H bonds, involving in each case those factors that are important in controlling the bond dissociation energy. (D.H.M.)

23048 RADIOLYSIS OF LIQUID NITROUS OXIDE. Robinson, M. G.; Freeman, G. R. (Univ. of Alberta, Edmonton). J. Phys. Chem., 72: 1394-6(Apr. 1968).

The radiolysis of pure liquid nitrous oxide and of nitrous oxide–cyclopentane solutions was investigated. The yields of nitrogen and oxygen for liquid nitrous oxide irradiated at 185°K were $G(N_2) = 12.9 \pm 0.2$ and $G(O_2) = 2.6 \pm 0.1$ independent of dose over the range 1 to 5×10^{18} eV/g. At 1×10^{19} eV/g, $G(NO_2) = 5.0 \pm 0.2$. The overall stoichiometry was the same as that found for the vapor phase radiolysis of nitrous oxide at 298°K and 600 torr. Since oxygen atoms react readily with hydrocarbons, the addition of cyclopentane to nitrous oxide decreased the $G(O_2)$, but the $G(N_2)$ decreased only at cyclopentane concentrations greater than 10^{-2} mole fraction, and the decrease was due mainly to the effect of dilution. Results indicate that energy transfer occurred from nitrous oxide to cyclopentane. (D.H.M.)

23049 LOW-FREQUENCY ELECTRON SPIN RESONANCE OF IRRADIATED ICE AND FROZEN SOLUTIONS OF HYDROGEN PEROXIDE. Hill, Marjorie J.; Wyard, S. J. (Guy's Hospital Medical School, London). J. Phys., B, 1: 289-94(Mar. 1968).

Electron spin resonance was studied at 280 MHz in irradiated ice and irradiated frozen hydrogen peroxide solutions. In polycrystalline ice a doublet splitting of 26 ± 1 gauss was observed, which is considerably smaller than the value of about 40 gauss recorded at 9.5 GHz. This difference was shown to arise from anisotropy of the g value. In a 70 wt % hydrogen peroxide glass the half-power linewidth obtained after the removal of spin–spin broadening by annealing was 7.5 ± 1 gauss, in good agreement with the theoretical value. The $\Delta M = 2$ transition was also observed in a hydrogen peroxide glass at 280 MHz, and the ratio of the intensity of this transition to the normal $\Delta M = 1$ transition was in reasonable agreement with the value predicted from high-frequency measurements. (auth) (UK)

23050 MECHANISM OF RADIOLYSIS OF GASEOUS HBr. Chen, J. D.; Armstrong, D. A. (Univ. of Calgary, Alberta). J. Chem. Phys., 48: 2310-15(Mar. 1, 1968).

The ion-pair yield for the decomposition of gaseous HBr by 120-kV x rays was determined from measurements of hydrogen yields and saturation ionization currents in an ionization chamber. At HBr pressures in the range 200 to 305 torr, M_{-HBr}/N is 4.8 ± 0.1. Up to one-half of this yield may be due to the excitation of HBr molecules to neutral excited states, and their subsequent dissociation to Br and H atoms. Under the conditions employed, all H atoms are expected to undergo reaction $H + HBr \rightarrow H_2 + Br$. A study of the effects of SF_6 indicated that the yield of scavengeable thermal electrons, which form hydrogen, is 3.1 per 100 eV. The results of competition experiments with this scavenger were incompatible with electron–positive-ion combination and the dissociative capture reaction, $e + HBr \rightarrow H + Br^-$, as sources of hydrogen molecules or atoms. They may be explained in terms of thermal electron capture reactions, which are second order in HBr. Physical evidence for at least one such process, viz., $e + 2HBr \rightarrow H + Br - H - Br^-$, was recently obtained. (auth)

23051 ABSORPTION SPECTRUM OF NEUTRAL CRYSTALLINE ICE γ IRRADIATED AT −196°C. Khodzhaev, O. F.; Ershov, B. G.; Pikaev, A. K. (Inst. of Physical Chemistry, Moscow). Izv. Akad. Nauk SSSR, Ser. Khim., No. 2, 246-9(Feb. 1968). (In Russian).

The absorption spectrum of crystalline ice, γ-irradiated at −196°C, was investigated. Absorption bands, belonging to the OH radicals (λ_{max} 280 nm) and captured electrons (λ_{max} 620 nm) were detected. The yield e^-_{cap} (~10^{-3}) was evaluated and the nature of the electron capture in crystalline ice at −196°C was considered. (tr-auth)

23052 DETECTION OF THE TRAPPED ELECTRON IN GLASSY AQUEOUS SOLUTIONS OF γ-IRRADIATED SUGARS AT 77°K. Makarov, I. E.; Ershov, B. G.; Pikaev, A. K. (Inst. of Physical Chemistry, Moscow). Izv. Akad. Nauk SSSR, Ser. Khim., No. 2, 447(Feb. 1968). (In Russian).

The formation of e^-_{cap} in glassy aqueous solutions of glucose, galactose, sorbose, rhamnose, saccharose, and maltose, irradiated with γ rays at 77°K, was studied by EPR and optical spectroscopy. In the case of glucose (4M) the EPR spectrum of e^-_{cap} presents a very narrow line with width at the point of maximum slope 10 ± 1 oersted in H_2O and 5 ± 1 in D_2O. In the optical spectrum this line corresponds with the absorption band with maximum at 560 nm, half width of 0.95 eV and the extinction coefficient in the maximum is 8×10^3 l/m · cm. The total radical yield is 3.7 and the e^-_{cap} is 1.5. (J.S.R.)

23053 ESR SPECTRUM OF THE RADICAL SPECIES TRAPPED IN X-IRRADIATED SINGLE CRYSTALS OF DIMETHYL (9-FLUORENYL) SULFONIUM BROMIDE. Lucken, E. A. C.; Mazeline, C. (Cyanamid European Research Inst., Geneva). J. Chem. Phys., 48: 1942-9(Mar. 1, 1968).

The electron spin resonance spectrum of single crystals of dimethyl (9-fluorenyl) sulfonium bromide, irradiated with x-rays at room temperature, reveals the presence of three free-radical species. Two of these were identified with reasonable certainty as $(CH_3)_2SBr$ (A) and 9-fluorenyl (B). The third radical (C) is probably one in which the unpaired electron is mainly localized on a sulfur atom i.e., RS. The components of the hyperfine coupling and g tensors for these radicals were determined and the results discussed in terms of the electronic structure of these radicals. For radical A the ^{79}Br and ^{81}Br nuclear quadrupole coupling constants were also determined. (auth)

23054 HISTORY OF THE TRANSURANIUM SYSTEMATICS. van Spronsen, J. W. RCN (Reactor Cent. Ned.) Meded., No. 29, 33-51(1967). (In Dutch).

Years before the first transuranium element was synthesized in 1940, several investigators were convinced that a second series of rare earth metals, analogous to the well-known rare earth metals, existed. Consequently these were indicated in some displays of the periodic system, e.g., by Thomsen, Werner, and Bohr. But others tried to demonstrate that U or, if need be, element 93 or 94 should be the lower limit of the periodic system. The experiments by Hahn et al. in 1935 gave indications for the existence of the transuraniums. Twelve such elements have been synthesized since 1940. It has been shown that these elements are actinides, indeed homologous to the rare earth metals. The experimental and theoretical work of Seaborg included a great part in this work. (tr-auth)

23055 TECHNOLOGICAL AND SCIENTIFIC ASPECTS OF RADIATION CHEMISTRY. Nauta, H. RCN (Reactor Cent. Ned.) Meded., No. 29, 109-30(1967). (In Dutch).

Radiation has been applied on a technical scale to preserve food, sterilize medical equipment, and to manufacture wood-plastic "alloys" and some graft copolymers. The very high yield of radioinduced polymerization of rigorously dried monomers has favorable industrial prospects. Pure scientific research in radiation chemistry yielded information on the properties of matter and the mechanics of chemical reactions. Investigations on radioinduced solid-state polymerization are important in radiation chemistry and radiation physics and give new insight in cooperative processes in chemical reactions. The discovery of the solvated electron led to better knowledge on electron transfer reactions, electron affinities, electron distributions in molecules and other fields. New insight was obtained about the transfer of energy from radiation to matter, a field of fundamental research with physical, chemical, and biological aspects. Several modern methods of research such as pulse radiolysis are discussed. (tr-auth)

23056 EFFECT OF GAMMA IRRADIATION ON STABILIZED POLYPROPYLENE. Aneli, D. N.; Nechitailo, N. A.; Sanin, P. I. Plast. Massy, No. 6, 14-17(1967). (In Russian).

The concentration of free radicals in stabilized irradiated polypropylene was determined, and the data were compared with the gel-fraction content of the polymer. EPR spectra were obtained for irradiated pure polypropylene and for the polymer stabilized with ionol, phenyl-β-naphthylamine, and 3,5-di-tert-butylpyrocatechol. Free radicals, at concentrations ranging from 0.6 to 1.6×10^{18} radicals/g of material, were formed in the pure and in the stabilized polypropylene. When the crystal structure of irradiated pure polypropylene or polypropylene containing ineffective additives (phenyl-β-naphthylamine) is ruptured, e.g., by melting or solution, the free radicals disappear due to recombination. Crosslinkage occurs and a gel fraction is formed. When effective additives such as the phenols cited are used, the recombination is via an ionic mechanism, and apparently the reaction between the free radicals of the polymer and the stabilizer is possible without crosslinkage and consequently without gel formation. Irradiated polypropylene containing certain additives is oxidized on prolonged storage in air. Secondary free radicals, among them a significant number of the inhibitor free radicals, are formed, as in thermal oxidation, only much more slowly. (ATD)

23057 UNSTABLE INTERMEDIATES. PART L. THE NO_3^{2-} IMPURITY CENTRE IN IRRADIATED CALCIUM CARBONATE. Eachus, R. S.; Symons, M. C. R. (Univ. of Leicester, Eng.). J. Chem. Soc., A, No. 4: 790-3(1968).

The radical NO_3^{2-}, prepared by the action of γ-rays on calcium carbonate doped with nitrate, was identified by its ESR spectrum and found to be remarkably stable in the host lattice. The results were used to obtain a $2p/2s$ value of 7.8 for the molecular orbital of the unpaired electron on nitrogen. This is compared with the results for the isoelectronic radicals CO_3^{3-} (5.25) and CF_3 (~3), and reasons for the marked differences are proposed. (auth)

23058 INFLUENCE OF GAMMA RADIATION ON THE ACID AND BASE ABSORPTION OF LEATHERS. Strakhov, I. P.; Yasin, Akhmedi; Balashova, N. S. (Moscow Tech. Inst. of Light Industry). Izv. Vyssh. Ucheb. Zaved., Tekhnol. Legk. Prom., No. 6, 68-72(1966). (In Russian).

The effect of γ radiation on the acid and base absorption of leather treated with dicyanodiamide resins was investigated. The investigation supplements the results obtained by I. P. Strakhov, P. I. Levenko, and I. G. Shifrin. The specimens (in pulverized form) were irradiated with a ^{60}Co source. The chemical composition and the acid and base absorption of the irradiated specimens were determined. The experimental results are shown in graphs and tables. The acid absorption was maximum at an irradiation dosage of 10^4 RAD. It is concluded that, at an irradiation dosage of 10^5 RAD, vulcanization processes predominate in the irradiated specimens over the destructive processes. (ATD)

23059 NATURE OF RADIATION-CAUSED DISTURBANCES IN IRRADIATED SPECIMENS OF POTASSIUM SULFATE. Gromov, V. V.; Karaseva, L. G. (Inst. of Physical Chemistry, Moscow). Khim. Vys. Energ., No. 1, 51-7(1967). (In Russian).

An investigation of the nature of radiation defects in sulfates of alkali-earth and alkaline elements was continued. The γ radiolysis of polycrystalline specimens and monocrystals of potassium sulfate was investigated by the electron paramagnetic resonance (EPR) method. Two types of radiation disturbances arising on γ irradiation with ^{60}Co were identified: the ion-radical SO_4^-, which disappeared at +100°C, and the ion-radical SO_3^-, which was stable at temperatures of <350°C. The principal values of the g-factors of these radicals and the radiation yields were determined. On the basis of these findings the interpretation of certain EPR signals presented in the aforementioned previous investigation must be revised: it is clear that in strontium and barium sulfates irradiated with γ-quanta at the temperature of liquid nitrogen the thermally stable signal with the g-factor of 2.004 is conditioned by the ion-radical SO_3^- arising on radiolysis, as well as during the decomposition of the ion radical SO_4^-. The latter has a mean g-factor of approximately 2.015 and, with its tri-axial anisotropy of paramagnetic susceptibility, it gives a wide asymmetric line in polycrystalline specimens. (JPRS)

23060 SPECTRA OF ELECTRON PARAMAGNETIC RESONANCE OF IRRADIATED FROZEN AQUEOUS SOLUTIONS. IV. ELECTRON STABILIZATION IN IRRADIATED NEUTRAL VITREOUS SOLUTIONS OF ELECTROLYTES. Ershov, B. G.; Pikaev, A. K. (Inst. of Physical Chemistry, Moscow). Khim. Vys. Energ., No. 1, 29-35(1967). (In Russian).

Investigations were continued on the clarification of the conditions of electron stabilization in neutral vitreous aqueous solutions of certain inorganic salts (KF, LiCl, NaH_2PO_4, Na_3PO_4, $NaClO_4$) frozen at −196°C and exposed to γ radiation. The investigation was performed by the EPR method, with the aid of a radiospectrometer. Optical absorption spectra were measured for γ-irradiated 10M KOH, NaOH, and $NaClO_4$ in H_2O and D_2O and traced to the transfer of charge to the solvent. Photoannealing of captured electrons, performed with the aid of an incandescent lamp, was found to lead to the formation of additional numbers of hydrogen atoms in the case of aqueous solutions of $NaClO_4$ and phosphates. The mechanism of electron stabilization is explained from the standpoint of the cavity theory: it may be assumed that electron stabilization occurs on vacancies in the electrical field generated by oriented polar molecules of water, which presupposes the presence of specific cavities. The nature of the electron capture centers in frozen vitreous solutions is fundamentally the same as in the case of liquid water. The only difference is that the potential well (associated with a definite orientation of polar molecules) in the case of liquid water is created by the electron itself, whereas in aqueous vitreous solutions at low temperatures these cavities exist prior to the irradiation. (JPRS)

23061 INVESTIGATION OF THE MECHANISM OF RADIATION-CATALYTIC PROCESSES ON SYNTHETIC ZEOLITES BY THE EPR METHOD. Breslav, Yu. A.; Kotov, A. G.; Pshezhetskii, S. Ya. (Inst. of Physical Chemistry, Moscow). Khim. Vys. Energ., No. 1, 65-70(1967). (In Russian).

The nature of active sites of radiation catalysis and the mechanism of radiolysis of substances with various electron properties at the surface of various zeolites were investigated. Specifically, this refers to the radiolysis of molecules of methyl alcohol, methylamine, methyl iodide, and formic acid adsorbed on the zeolites NaA and CaA. The adsorption on zeolites was performed at room temperature and at the temperature of liquid nitrogen. The irradiation dose was 2 Mrad and the EPR spectra were recorded at −196°C. The radiation yields of free radicals were determined by the EPR method during the radiolysis of molecules displaying electron-donor properties (CH_3OH, CH_3NH_2) on the surface of NaA. Radiolysis of this zeolite produced V-centers. Similar yields of free radicals were obtained on radiolysis of electron-acceptor substances on the surface of CaA (radiolysis of this zeolite produced F-centers). Apparently the mechanism of radiolysis of adsorbed molecules depends on their ability to form a primary complex with the positively or negatively charged (V- or F-) centers of the zeolite, with the dissociation of the molecules occurring as a result of subsequent recombination with the particle having an opposite charge (electron or hole). The dissociation of molecules incapable of forming complexes of this kind may occur when excitation energy is transmitted to them (possibly in the form of a nondissociated exciton) from the zeolite. (JPRS)

23062 STUDY OF THE PHOTOSENSITIVITY OF PARAMAGNETIC SPECIES ARISING FROM RADIOLYSIS OF HALOGENATED RUBBERS. Kozlov, V. T.; Kryukova, A. B.; Zueva, M. V. (Sci-

entific Research Inst. of the Rubber Industry, Moscow). Khim. Vys. Energ., 1: 504-6(1967). (In Russian).

The ESR method was used to study the photosensitivity of paramagnetic particles formed during dark low-temperature radiolysis (under visible and uv light) of polychloroprene (Nairit "B"), a vinylidene fluoride–hexafluoropropylene copolymer (Viton type elastomer), and a vinylidene fluoride–trifluorochloroethylene type copolymer (Kel-F type elastomer). The experimental results indicate that radiolysis of Viton and Kel-F type elastomers gives rise to paramagnetic particles of different types, including free radicals stable to the action of light and photosensitive paramagnetic particles of two types–presumably anions formed by the capture of electrons by fluorine atoms in $-CF_2-$ and $-CF$ groups. Radiolysis of polychloroprene gave rise only to free radicals stable to the action of light. (ATD)

23063 CHEMONUCLEAR REACTORS. Spurny, Zdenek (Ustav Jaderneho Vyzkumu CSAV, Prague). Chem. Listy, 61: 1557-70(Dec. 1967). (In Czech).

The literature (32 references) was reviewed on the use of chemical reactors in which the reaction is promoted with nuclear energy. The types of chemonuclear reactors are classified as radiation, thermal, electro, and other, e.g., photochemonuclear. The system is briefly described in which the mixture to be irradiated is circulated in a loop that is located partially in the radiation field of a ^{235}U fission product source. Some of the processes suitable for such a system are fixation of atmospheric nitrogen, condensation of methyl alcohol to ethylene glycol, and formation of hydrazine from ammonia. The radionuclide ^{85}Kr may be used as a gaseous radiation source. Dow uses ^{60}Co in synthesizing ethylene bromide. The problems of desalting sea water are mentioned, and a scheme using nuclear reactors to accomplish this is presented. (TTT)

23064 KINETICS OF THE RADIATION-THERMAL DECOMPOSITION OF NO_2 IN FLOW. Nichipor, G. V. (Inst. of Nuclear Power, Minsk). Vestsi Akad. Navuk BSSR, Ser. Fiz.-Tekh. Navuk, No. 4, 29-34(1967). (In Russian).

A mathematical description is given the kinetics of the radiation-thermal decomposition of nitrogen dioxide in one-dimensional flow with use of the known equations of energy and mass transfer. The reaction mechanism was examined. The ratio of the rates of the initial radiation and thermal decompositions of NO_2 was evaluated. It was shown, as a function of temperature at dose output $\sim 10^{16}$ eV/cm^3 · sec, that in the range $T \geq 500°K$ the spatial-time distribution of the mixture components can be neglected, but this is valid only at the very beginning of the chemical stage. Under conditions of high temperature flow, effects caused by the effect of thermal decomposition of NO_2 on the radiation decomposition were additive. In this case the process is described by a system of 8 differential equations of the first order with nonlinear right-hand terms. (tr-auth)

23065 MATHEMATICAL MODEL FOR RADIATION POLYMERIZATION IN PREPARING GLUED FIBROUS MATERIALS BY IRRADIATION. Tikhomirov, V. B.; Baidukova, G. F.; Borisevich, V. A. (Moscow Textile Inst. Belorussian Inst. of Nuclear Power Engineering, Minsk). Vestsi Akad. Navuk BSSR, Ser. Fiz.-Tekh. Navuk, No. 3, 127-9(1967). (In Russian).

The radioinduced polymerization of styrene on a glass fiber in a solution was investigated from a mathematical model point-of-view. The radiation dose, concentration of monomer in the solution (ethanol), and the phase ratio (of solution and fiber) were taken as the independent variables as a result of preliminary studies performed on a ^{60}Co gamma irradiator having an output of 50 Rads/sec. The following regression equation was obtained: $y_r = 28.84 + 7.34\,x_1 + 4.92\,x_2 - 1.27\,x_3 + 4.25\,x_1x_2 - 6.75\,x_1x_3 + 2.00\,x_2x_3 - 1.80\,x_1^2 - 3.57\,x_3^2$. Here x_1 is the irradiation dose in 10^6 Rads; x_2 is the concentration of monomer in solution in %, and x_3 is the ratio of phases. This equation is a mathematical model of the radiation polymerization of styrene on a viscous fiber. It describes an elliptic paraboloid. The data show that it is possible to obtain a fiber with 40% polymer content, which will adhere to the fiber at a relatively small irradiation dose. (TTT)

23066 UNSATURATION CHANGES AND OTHER RADIOLYTIC REACTIONS IN POLYETHYLENE. II. AN EXAMINATION OF CROSSLINKING WITH GEL PERMEATION CHROMATOGRAPHY. Lyons, Bernard J.; Fox, Adrian S. (Raychem Corp., Redwood City, Calif.). J. Polym. Sci., Part C, No. 21, 159-70(1968).

A method of determining crosslink yields and examining crosslink statistics in polymers is described. The soluble fraction of materials crosslinked to well above their gel point was examined with gel permeation chromatography and compared with the original material. The results of the soluble fractions of irradiated polyolefins indicated that the random statistical crosslinking mechanism first suggested by Charlesby was followed closely by low-density polyethylenes. The high-density polyethylenes examined show deviations from statistical behavior, which may be attributed to dimerization or endlinking through vinyl decay. However, other factors may also be involved. The results suggest that G (crosslinks) does not change significantly with dose and that the ratio of chain scission to crosslinks is less than 0.03 in the range up to 80 MRad in a low-density polyethylene. (auth)

23067 REACTIONS OF NITROSODIMETHYLANILINE WITH FREE RADICALS. Dainton, F. S.; Wiseall, B. (Univ. of Leeds, Eng.). Trans. Faraday Soc., 64: 694-705(Mar. 1968).

The changes in the absorption spectra of aqueous Ar-, N_2O-, or O_2-saturated solutions of p-nitrosodimethylaniline (P) subjected to γ-rays under steady-state conditions or to 2.9 MeV electron pulses, and the effects of various OH radical scavengers S (and some e^-_{aq} scavengers), were measured. The optical density of the solutions at 440 nm, where P absorbs strongly, initially diminished rapidly due to reactions of P with e^-_{aq} ($K = 3.4 \times 10^{10}$ M^{-1} sec^{-1}), confirmed by measurement of the effect of P on $G(N_2)$ for γ-radiolysis, and OH ($k = 1.8 \times 10^{10}$ M^{-1} sec^{-1}), and then underwent partial or complete, rapid or slow, recovery, dependent on the nature of both S and the dissolved gas. Rate constants of reactions of P with the oxidized form of S were measured. O_2^- did not react with P, but the complexities of the secondary reactions prevented calculation of reliable values of k for OH + S from the effect of S on G(— P) for steady-state conditions. The effect of S on the maximum O.D. change at 440 nm following pulse radiolysis of O_2-saturated solutions can be used to obtain trustworthy values of k(OH + S) in specified cases. (auth) (UK)

23068 PREPARING ^{147}Pm FROM A TARGET OF NEODYMIUM OXIDE BY ION EXCHANGE. Mikhailova, Vera. Izv. Fiz. Inst. Aneb, Bulg. Akad. Nauk., 16: 103-9(1967). (In Bulgarian).

Optimum conditions were determined for the separation of carrier-free ^{147}Pm from a 100 mg target of Nd_2O_3 irradiated by thermal neutrons. Use was made of a cation-exchange resin and citrate buffer solution for eluent. It was established that the efficient separation of promethium calls for charging the column to under 2% of its capacity. Following the method of consecutive approximations, the most suitable composition was selected for the eluating solution under the conditions of the experiment. Two ^{147}Pm sources were obtained. The first one gives yields of 98% and contamination of Nd under 0.12% with elution time 48 hours, while the second one gives yields of 98% and Nd contamination of under 0.015% with elution time of 102 hours. (auth)

23069 ELECTRON SPIN RESONANCE STUDIES OF FUNDAMENTAL PROCESSES IN RADIATION- AND PHOTO-CHEMISTRY. PART 5. DISSOCIATIVE ELECTRON CAPTURE IN AMINO ACIDS AT LOW TEMPERATURES. Ayscough, P. B.; Roy, A. K. (Leeds Univ., Eng.). Trans. Faraday Soc., 64: 582-95(Mar. 1968).

The radiolysis of α-amino acids $RCH(NO_2^+)COO^-$ where R = H, CH_3, CH_3CH_2, CH_2COOH, or CH_2SO_3H was examined by ESR methods. After γ-irradiation at 77°K the predominant ESR spectrum observed at this temperature corresponded to the protonated molecular–anions $RCH(NH_2^+)COOH^-$ formed by electron capture followed by proton transfer. These ions were de-aminated at a higher temperature to yield the radicals RCHCOOH, known from earlier studies to be stable at room temperature. When irradiated as aqueous alkaline glasses at 77°K only trapped electrons, O^-_{aq} and $R\dot{C}HCOO^-$ radicals were observed and it was concluded that the non-protonated species $RCH(NH_2^+)\dot{C}OO^{2-}$ were insufficiently stable for trapping in this matrix. Single crystal data were analyzed to give the proton hyperfine tensors for the species $CH_3CH(NH_2^+)\dot{C}OOH^-$, $HOSO_2CH_2CH(NH_2^+)\dot{C}OOH^-$ and $HOSO_2CH_2$-$CHCOO^-$, the latter two species being derived from cysteic acid. (auth) (UK)

23070 SINGLE CRYSTALS OF POLYETHYLENE PRODUCED BY γ-RADIATION-INDUCED POLYMERIZATION. Machi, Sueo; Toyota, Nobuhiro (Japan Atomic Energy Research Inst., Takasaki, Japan). J. Polym. Sci., Part A-2, 6: 289-93(Jan. 1968).

The formation of single crystals from γ-induced polymerization of polyethylene is reported. The molecular weight of the polymer markedly affected the morphology of the crystal. The fraction of lowest molecular weight (19,000) was found to grow in the form of diamond-shaped, slightly truncated, single crystals. Good uniformity in platelet size and thickness was observed. The fraction with medium molecular weight of 64,000 grew as a much truncated lozenge. The morphology of the fraction with the highest molecular weight, 260,000, was not dentritic, but the fraction was comprised of oval-shaped crystals. (D.H.M.)

23071 CHANGE WITH TEMPERATURE OF THE ESR SPECTRA OF PEROXY RADICALS TRAPPED IN IRRADIATED

POLYTETRAFLUOROETHYLENE. Iwasaki, Machio; Sakai, Yoshiro (Government Industrial Research Inst., Nagoya, Japan). J. Polym. Sci., Part A-2, 6: 265-79(Jan. 1968).

The ESR spectra of peroxy radicals in irradiated powders and oriented samples of polytetrafluoroethylene (PTFE) were measured with a K-band spectrometer, and the principal values and directions of the g tensor were determined both at room temperature and at 77°K. In contrast to the spectra of the usual peroxy radicals, those trapped in γ-irradiated PTFE exhibited an ESR spectrum apparently having a larger principal value for $g_\perp$ than for $g_\parallel$ when measured at room temperature, although the normal principal values were observed at 77°K. As for the directions of the principal axes, $g_\parallel$ was directed along the chain axis at room temperature and was perpendicular to the chain axis at 77°K. From the temperature change of the g tensor and the line shapes in the oriented samples, it is shown that the observed temperature change of the spectra is due to rapid rotation at room temperature around the chain axis rather than around the C—O bond axis. Assuming this, the apparent principal values of the g tensor at room temperature were calculated from the g tensor obtained at 77°K, for the rigid state, and the results are in good agreement with observations at room temperature. A structure for the peroxy radicals is also proposed. The spectral line shape function for the uniaxially oriented samples was derived. (auth)

23072 GAMMA-RADIOLYSIS OF AQUEOUS BENZENE SOLUTION. Hung, Tsu-chang. Bull. Inst. Chem., Acad. Sinica, No. 14, 1-13(Dec. 1967).

Oxygen-saturated aqueous benzene solutions in 0.4M sulfuric acid containing a small amount of ferrous sulfate or ferric sulfate were irradiated by ^{60}Co gamma rays at room temperature and at 160°C. G(phenol) and G(ferric ion) or G(ferrous ion) were found to be affected by the total doses absorbed. In the irradiation of very dilute ferrous sulfate solutions, the yield of phenol was higher than in the ferric sulfate solution. Higher G-values of 93.1 molecules per 100 eV for phenol and 183 molecules per 100 eV for ferric ions were observed in the presence of ferrous ions at the doses of 7.32×10^{17} eV per gram and at 160°C. Such a high G value of phenol was due to the reaction of ferrous ion with dissolved oxygen, and the formation of OH radical as well as the hydroxycyclohexadienyl peroxy radical. Mechanisms are proposed and chain reactions for the oxidation of ferrous to ferric ions, or the reduction of ferric to ferrous ions and the oxidation of benzene to phenol are discussed. Oxygen was thought to have played an important role in the initiation of the chain reactions. (auth)

23073 FREE RADICAL FORMATION IN A GAMMA-IRRADIATED PYRIMIDINE–PURINE CO-CRYSTAL COMPLEX. Schmidt, Jack; Snipes, Wallace (Pennsylvania State Univ., University Park). Int. J. Radiat. Biol., 13: 101-9(1967).

The formation and properties of free radicals in a co-crystal complex between 1-methylthymine and 9-methyladenine were studied by electron spin resonance spectroscopy. It was found that the radicals formed in this complex do not represent a simple composite of those formed in the individual components. For irradiation at 77°K, the location of the radical(s) in the complex could not be determined, but at 300°K radicals were preferentially formed on the 1-methylthymine moiety. The radical on the 1-methylthymine moiety at 300°K was formed by hydrogen addition on C_6 of the thymine ring. This radical had greater conformational stability and resistance to heat decay when in the co-crystal complex than when in the 1-methylthymine crystal structure. (auth)

23074 MECHANISM OF ELEMENTARY REACTIONS INVOLVING HOT ATOMS OF HYDROGEN. Brodskii, A. M.; Temkin, A. Ya. (Inst. of Electrochemistry, Moscow. Inst. of Petrochemical Synthesis, Moscow). Khim. Vys. Energ., No. 1, 4-9(1967). (In Russian).

The mechanisms and kinetics of hot-atom reactions can be primarily understood by knowing the energy range within which these reactions occur. A survey of the experimental findings on reactions between hot atoms of H and molecules of the ambient medium indicated that these reactions occur in the eV range of energies. At the same time, they are extremely sensitive to relatively small changes in the structure of the electron shell of molecules. A two-stage mechanism is suggested as a means of accounting for these phenomena: resonance scattering of hot atom on discrete atoms of molecules of the medium and subsequent transmission of energy to the remaining part of the molecule. The phenomenologically introduced partial widths of these additional channels are considered small compared with the partial widths of the other processes. This mechanism is used to interpret the experimental findings on the rates of various reactions of hot tritium and to discuss the possibilities of organizing further experiments. (JPRS)

23075 CHEMICAL EFFECT OF HOT ATOMS OF HYDROGEN ON ISOPROPYL ETHER. Filatov, E. S.; Koltan, L.; Nesmeyanov, N. An. (Moscow State Univ.). Khim. Vys. Energ., No. 1, 10-14 (1967). (In Russian).

To elucidate the mechanism of reactions of hot atoms of H, the distribution of products containing recoil atoms of T, arising during the nuclear reaction of $^6Li(n,\alpha)T$ in liquid isopropyl ether, was investigated. The irradiated specimens were analyzed by radiochromatographic methods and by vacuum distillation of microamounts of substances in combination with concentration of high-boiling-point compounds. If the formation of T-containing products passes through the stage of formation of excited tagged molecules, then the spectrum of the products of hot reactions must resemble the spectrum obtained on radiolysis of the ether. Since the established distribution of T atoms differs from the radiation-chemical distribution of the corresponding (untagged) products, it appears that the pattern of decay of the intermediate products of the reactions of hot atoms of H in isopropyl ether differs from the mechanism of decomposition of excited (or ionized) molecules in radiolysis: highly excited molecules of isopropyl ether containing recoil atoms following the H substitution reaction apparently break down into products which, in the course of subsequent reactions, yield substances with a higher molecular weight than the original substances. (JPRS)

23076 RADIOLYSIS OF AQUEOUS SOLUTIONS OF BENZENE IN THE PRESENCE OF IONS OF VARIABLE-VALENCE METALS. I. SOLUTIONS IN 0.4M H_2SO_4 CONTAINING IONS OF BIVALENT IRON AND OXYGEN. Kartasheva, L. I.; Pikaev, A. K. (Inst. of Physical Chemistry, Moscow). Khim. Vys. Energ., No. 1, 22-8(1967). (In Russian).

A detailed investigation of radiolytic transformations in aqueous solutions of benzene containing Fe^{2+} ions and oxygen, during radiolysis in 0.4M H_2SO_4, was undertaken to determine the reasons for the increase in the radiation yield of phenol in the presence of Fe^{2+} ions. The investigation was performed with the aid of γ radiation from ^{60}Co; the absorbed dose was determined by the ferrosulfate method. The yields of Fe^{3+}, phenol, muconic aldehyde, and hydrogen were measured as a function of dose rate and concentrations of Fe^{2+}, Fe^{3+}, and C_6H_6. These yields decreased with an increase in Fe^{2+} concentration and increased with an increase in benzene concentration. The products of the radiolysis of the system evidently form as a result of a chain reaction in which an important role is played by peroxide oxycyclohexadienyl radicals and peroxide compounds of benzene. Rate constant ratios were determined for a number of reactions; it was established that the ratio between the rate constants of reactions between OH radicals and Fe^{2+} ions and C_6H_6 is 0.15. (JPRS)

23077 γ-RADIATION INDUCED COLOR CENTERS IN ANTHRACENE. Blum, Haywood; Mattern, P. L.; Arndt, R. A.; Damask, A. C. (Brookhaven National Lab., Upton, N. Y.). Contract AT(30-2)-Gen-16. Mol. Crys., 3: 269-80(1967). (BNL-11461).

The effects of γ irradiation on pure anthracene were investigated by optical absorption and electron paramagnetic resonance (EPR) measurements. It is found that the optical absorption peaks produced by the radiation at 30°C are stable at 30°C but increase on annealing up to 140°C; the most prominent of these are at 6060 and 5350 Å. EPR signals arising from irradiation are stable to 140°C but do not grow between 30 and 140°C. Both optical density and EPR signals decrease on annealing above 190°C. A model is proposed to explain the nature of the EPR signals based on cross-linking of the anthracene molecules. (auth)

23078 PHOTOCHEMICAL AND RADIATION-INDUCED REDUCTION OF NITRATE ION IN PURE AND SEA WATERS. Hung, Tsu-chang; Hu, Sing-hua. Bull. Inst. Chem., Acad. Sinica, No. 14, 29-35(Dec. 1967).

Pure water and seawater enriched with various concentrations of nitrate ions were exposed to γ, uv, and solar radiations. Yields of ammonia, nitrite ions, and hydrogen peroxide were analyzed. The only photochemical yields in alkaline solutions were nitrite ions. Yields of nitrites in seawater were found to be a little higher than those in pure water. Irradiation with solar radiation produced very low concentrations of nitrite ions and ammonia. Yields of nitrite ions and ammonia were found to be nonlinear with the time of irradiation. Mechanisms for the photochemical reduction of nitrates to nitrites in dilute alkaline solutions are proposed. (J.G.B.)

23079 DE WISSELWERKING TUSSEN CHEMIE EN KERNENERGIE. (The Interplay Between Chemistry and Nuclear Energy). de Boer, J. H.; D'hont, M.; van Spronsen, J. W.; Kraak, W.; Cordfunke, E. H. P.; Schutte, L.; Nauta, H.; Goedkoop, J. A. RCN (Reactor Cent. Ned.) Meded., No. 29. The Hague, Reactor Centrum Nederland, 1967. 142p.

Seven papers are included and a separate abstract was prepared for each. (M.C.G.)

For abstracts of individual papers see: 22955, 23019, 23021, 23054, 23055, 23080, and 25144.

23080 GENERAL INTRODUCTION. D'hont, M. RCN (Reactor Cent. Ned.) Meded., No. 29, 15-32(1967). (In Dutch).

The development of the Dutch nuclear industry was directed mainly towards industrial use and was based on the electronic, petrochemical, and plastic industries already present. The Belgian development was directed to several subjects of more basic research. The purposes of nuclear science are the production of nuclear energy, production of isotopes, and the use of radiation effects. Some of these have many applications in chemistry. Chemical research has to provide solutions for many problems in nuclear industry, of which the waste disposal is most important. The application of nuclear energy may solve problems in food production and water purification. (J.J.t.B.)

23081 METHOD FOR PRODUCING VANILLINE BY IRRADIATION. Kinoshita, Shosaku (to Osaka Prefecture). Japanese Patent 1967-7530. Mar. 27, 1967. Filed Nov. 27, 1964.

Vanillin, an important perfume for foods, is produced by irradiating the starting material isoeugenol with high-energy ionizing radiation in the presence of O_2. For example: 0.054 g of isoeugenol in contact with 25 ml of O_2 was irradiated with γ rays at a dose rate of 1×10^6 RAD/hr. to the total dosage of 10^8 RAD while cooled with water. Then, 0.05 g of vanillin was obtained, corresponding to nearly a 100% yield. The cooling by water is necessary to prevent the decomposition and the polymerization of the reactant at high temperatures caused by the high radiation dose rate. (NSA of Japan)

23082 METHOD FOR REFINING GERANIOL BY IRRADIATION. Kinoshita, Shosaku. Japanese Patent 1967-3800. Feb. 17, 1967. Filed July 9, 1963.

The quality of geraniol is improved by irradiating with 10^7 to 10^8 RAD of high-energy ionizing radiation such as γ rays or electrons while O_2 or O-containing gas is flowed above or bubbled through the geraniol. Part of the geraniol is converted into nerol and some unknown substances which are thought to be dimer or trimer of nerol or geraniol from the slight increase in viscosity. The quality of the mixture produced is excellent as a perfume and is not inferior to the high-grade natural geranium oil. (NSA of Japan)

23083 RADIOISOTOPE CATALOG. Tel-Aviv, Israel, Israel Atomic Energy Commission, 1967. 148p.

Standard isotopes available are tabulated. Additional isotopes can be made to order by service irradiations followed by appropriate processing, which is described. Special isotopes obtainable upon request are listed. (P.C.H.)

Radiochemistry

Refer also to abstracts 23079 and 23481.

23084 (BNWL-SA-1644) NEUTRON AND PHOTON SPECTRA, DOSE RATES AND ITS CHANGES WITH TIME SINCE CHEMICAL SEPARATION FOR HIGH-EXPOSURE PLUTONIUM. Faust, L. G. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Jan. 1968. Contract AT(45-1)-1830. 16p. (CONF-680302-4). Dep. CFSTI.

From International Symposium on Nuclear Electronics and Radioprotection, Toulouse, France.

Theoretical expressions are presented, which describe the radiation levels and resultant dose rates expected from plutonium. The expression for photon dose rates is based on the isotopic composition of the plutonium, the time since chemical separation and the energies and yields of the photons accompanying radioactive decay; the expressions for neutron dose rates are based on isotopic composition, mass, and chemical/physical form. Photon energy spectra change significantly at relatively short times after chemical separation primarily due to the buildup of ^{237}U and ^{241}Am, the daughters of ^{241}Pu. The bulk of the photons are of low energies and, therefore, minimal shielding, such as can be added to glove boxes or hoods, will reduce the personnel exposure significantly. Data do show that surface dose rates from plutonium containing three or more weight percent ^{241}Pu will increase a factor of two within one year of chemical separation. Neutron energy spectra are presented for PuF_4 and PuO_2. It is easily seen that the average energies are different and that the fission tail is present in the PuO_2 sample that contains significant quantities of the isotopes that fission spontaneously. (auth)

Separation Processes

Refer also to abstracts 22932, 22934, 22935, 22984, 23190, 23191, 23221, 23751, 23854, 23864, 24788, 25073, and 25172.

23085 (AAEC/E-187) CONCEPTUAL DESIGN STUDY OF A LOW THROUGHPUT REPROCESSING FACILITY FOR NUCLEAR FUEL. Cairns, R. C.; May, J. R.; Baillie, M. G.; Farrell, M. S. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Nov. 1967. 53p. Dep.

The idea of reducing fuel reprocessing costs by changing reprocessing plant design philosophy is explained. It is shown how a significant reduction in unit reprocessing costs can lead to earlier recovery of nuclear material. A classification is given of some existing nuclear chemical reprocessing plants as a function of their maintenance philosophies. The feasibility of the rack concept is discussed for application to a conceptual low-throughput reprocessing plant specifically designed for reprocessing fuel from the A.A.E.C.'s Dido-class reactor HIFAR. Laboratory and design development work is described. Preliminary cost estimates are given for a site at the Research Establishment, Lucas Heights, with maximum use of existing facilities, services, and plant. The study did not reveal any technical difficulties that would make the rack concept impractical. The concept of indirect maintenance for items of equipment likely to require frequent attention is technically feasible, and it appears possible to remove racks for repair of equipment by normal direct maintenance techniques. Additional development followed by plant construction and operation would be necessary to verify these conclusions and to establish any cost advantages. However, the cost estimates deduced at the start of the study did not change substantially during the course of the work. (auth)

23086 (ANL-7421) SEPARATION OF TRACES OF METAL IONS FROM SODIUM MATRICES. Korkisch, J.; Orlandini, K. A. (Argonne National Lab., Ill.). Feb. 1968. Contract W-31-109-eng-38. 7p. Dep. CFSTI.

A rapid and quantitative method for the isolation of traces of metal ions from sodium matrices (e.g., sea water) is described. The technique consists of two extractions and an ion exchange step. In the first extraction, metal ions that form stable TTA-complexes in sodium chloride solutions, which are buffered with sodium acetate to a pH of 4.7 to 6.1, are extracted with 0.1M TTA in benzene–tetrahydrofuran. More than 30 elements, including rare earths, uranium, thorium, titanium, zirconium, and hafnium, are completely extracted under these conditions. Following this extraction, other traces of metal ions (i.e., silver, mercury, and cadmium) are extracted from the same aqueous solution using 0.001M dithizone in benzene as the extractant. To remove residual sodium ion from the two organic extracts, this element is selectively adsorbed on the strongly acidic cation exchanger Dowex 50 from the organic phases after the addition of pyridine. Following this final purification step, the elements thus isolated can be determined radiometrically. (auth)

23087 (BARC-315) USE OF VERMICULITE FINES IN CONJUNCTION WITH CHEMICAL TREATMENT FOR DECONTAMINATION OF RADIOACTIVE EFFLUENT. Bonhote, P. A.; Jha, J. C.; Thomas, K. T. (Bhabha Atomic Research Centre, Bombay (India)). 1967. 15p. Dep.

Low-level radioactive effluent may be decontaminated by a two-stage process utilizing chemical flocculation and ion exchange on vermiculite. Vermiculite was used either in columns or in a basket centrifuge. The possibility of combining the two stages is examined. The results of a series of laboratory experiments to evaluate the effects of particle size, contact time, sequence of addition, and different chemical treatments are reported. It is considered that fine vermiculite may be added to the chemical flocculation process, thus eliminating the need for columns or a centrifuge, and reducing the cost of treatment. (auth)

23088 (BM-RI-7123) RECOVERY OF CERIUM AND LANTHANUM BY OZONATION OF LANTHANIDE SOLUTIONS. Bauer, Donald J.; Lindstrom, R. E. (Bureau of Mines, Reno, Nev. Reno Metallurgy Research Center). May 1968. 11p. Bureau of Mines Free.

Oxidation of mixed lanthanide solutions with ozone at pH 4.5 and at ambient temperature resulted in precipitation of 98% of the original cerium present. Corresponding cerium purity was increased from 50 to 98%. A second ozone oxidation-precipitation step produced cerium of 99.9% purity in high yield from the 98%-pure material. Alternately, ozonation of pH 6.5 and 85°C differentially precipitated cerium and rare earth elements heavier than cerium and left 89% of the original lanthanum in solution at a purity of 95%. Subsequent recovery of cerium from the heavier rare earth elements in the precipitate was accomplished by dis-

solving the precipitate in dilute mineral acid and reoxidizing the cerium with ozone at pH 4.5 and at ambient temperature. The filtrate contained an enriched praseodymium–neodymium–samarium–europium mixture that is amenable to separation by ion exchange or solvent extraction. (auth)

23089 (CONF-670502–, pp 678-90) COMMERCIAL ION EXCHANGE SEPARATION OF THE RARE EARTHS. Silvernail, W. L.; Woyski, M. M. (American Potash and Chemical Corp., Los Angeles, Calif.).

Rapid production of yttrium is achieved by making use of the different positions of yttrium in the elution sequence with different eluting agents. Elution with HEDTA is used to separate the heavy elements. This is followed by elution with EDTA to separate the light elements. Elution with EDTA is carried out with a pre-prepared solution of rare earth chelate. This permits operation at much higher concentration and facilitates the recovery of EDTA. The use of non-rare earth retainers is eliminated. In actual operation, columns loaded with crude material are introduced into the elution train at suitable intervals resulting in almost continuous production of purified product. The use of pre-prepared solutions of rare earth chelates is also applicable to the separation of other rare earths with a gain in operating efficiency. Some fundamentals of commercial ion-exchange operation are considered. (auth)

23090 (CONF-670502–, pp 692-700) RECOVERY OF CERIUM AND LANTHANUM BY OZONATION OF LANTHANIDE SOLUTIONS. Bauer, D. J.; Lindstrom, R. E. (Bureau of Mines, Reno, Nev. Reno Metallurgy Research Center).

Oxidation of lanthanide solutions with ozone at pH 4.5 and ambient temperature results in precipitation of 98% of the original cerium present. Corresponding cerium purity is increased from 50 to 98%. Alternatively, ozonation at pH 6.5 and 85°C differentially precipitates cerium and heavier elements, and leaves 89% of the original lanthanum in solution at a purity of 95%. Subsequent recovery of cerium from the heavier elements is accomplished by dissolving the precipitate and reoxidizing the cerium with ozone at pH 4.5 and ambient temperature. The filtrate contains an enriched praseodymium-neodymium-samarium-europium mixture that is amenable to separation by ion exchange or solvent extraction. (auth)

23091 (CONF-670502–, pp 702-13) CRACKING PROCESS FOR RARE EARTH ORES BY DIRECT CHLORINATION AT HIGH TEMPERATURES ON A PRODUCTION SCALE. Brugger, W.; Greinacher, E. (Goldschmidt (Th.) A.G., Essen (West Germany)).

The direct chlorination of rare earth ores without resorting to carbides or similar compounds is described. Complete chlorination of all nonvolatile components of the ore results between 1000 and 1200°C in a special electrically heated furnace. The furnace is so constructed that it is possible to replace the most vital parts quickly and in a hot furnace, thereby bringing under control the unavoidable effects of corrosion. The flow sheet of the process is presented. The process permits a large productive capacity in a small space at low investment and low labor output. It is possible to process the most varied ores such as bastnasite, monazite, allanite, cerite, xenotime, euxenite, fergusonite, gadolinite, etc. in the same installation. The problems of conversion of off-gases are considered. As a final product fused anhydrous chlorides of the rare earths are obtained without thorium chloride and without oxychloride content. These chlorides are very well suited for the production of the corresponding metals. With a similar process pure rare earth oxides can be converted to the corresponding anhydrous chlorides. (auth)

23092 (CONF-660524–, pp 617-45) REPROCESSING OF URANIUM–THORIUM FUEL FOR HIGH-TEMPERATURE GAS-COOLED POWER REACTORS. Short, G. D. C.; Orsenigo, G.; Romberg, E. (United Kingdom Atomic Energy Authority, Sellafield (England). [Production Group]. Comitato Nazionale per l'Energia Nucleare, Rome (Italy). European Atomic Energy Community).

One objective of the Dragon Project was to study problems of the high-temperature reactor (HTR). To assess the generating costs of a HTR power plant, a conceptual design study for reprocessing of HTR fuel was initiated early in 1964. The size of the reactor program was put at 10,000 MW(t), and for the purpose of costing spent-fuel reprocessing and refabrication, it was decided that a central reprocessing-refabrication plant would be required. Some additional assumptions were as follows: fuel, $(U,Th)C_{2.4}$ (93% enriched, pyrocarbon–silicon carbide–pyrocarbon-coated particles of approximately 500 μm in diameter); burnup, 150,000 MWd/metric ton over 4 years; reloading, 25% of the core per year; thorium-to-^{235}U ratio, 12; and carbon-to-^{235}U ratio, 3000. On the basis of these specifications, the daily throughput of the reprocessing plant is approximately 90 kg of heavy metal and 1000 kg of carbon. Two routes are under investigation for the head-end treatment: a grind-leach process and a grind-leach process preceded by electrolytic compact disintegration. Decontamination and product separation is carried out by a modified Acid–Thorex process. The merits of low decontamination from coextracted U–Th–Pu associated with remote refabrication are compared with high decontamination of separated uranium as required for direct refabrication of HTR fuel in lightly shielded equipment. Capital and direct operating costs are presented for the grind-leach head-end process and the solvent-extraction separation system. (auth)

23093 (CONF-660524–, pp 653-69) ENGINEERING DEVELOPMENT OF ON-SITE PROCESSING FOR MOLTEN SALT BREEDER REACTORS. Whatley, M. E.; Carter, W. L.; Lindauer, R. B.; McNeese, L. E.; Scott, C. D.; Hightower, J. R. (Oak Ridge National Lab., Tenn.).

The proposed Molten Salt Breeder Reactor under consideration is a two-region, 1000-MW(e) machine using a graphite-moderated core with a circulating molten mixture of LiF, BeF_2, and $^{233}UF_4$ for fuel and a circulating molten mixture of LiF and ThF_4 in the blanket. A method for processing the fuel and blanket has been tentatively selected and has formed the basis for an engineering-development study. This paper describes the processing methods being considered and gives the state of technology upon which these processes are based. A conceptual design study has been made of a facility for which the capital cost is estimated at $5.5 million and the direct operating costs at $788,000 per year. Present technology presents an encouraging starting point for the development of processes that will make a molten-salt breeder reactor a reality. (auth)

23094 (IAEA–3431-4) INVESTIGATION OF MATERIALS AND METHODS FOR FIXATION OF LOW AND MEDIUM LEVEL RADIOACTIVE WASTE IN STABLE SOLID MEDIA. Fourth Progress Report, August 1, 1966–July 31, 1967. Rastogi, R. C.; Sehgal, J. D.; Thomas, K. T. (Bhabha Atomic Research Centre, Bombay (India)). 1967. 60p. (BARC–304). Dep. CFSTI.

The effects of Na_2S and $Na_2S_2O_3$ on suppression of Ru volatility during the glass fixation process was studied. By replacing the Na_2O content of the glass mix with Na_2S, up to 99.9% of the Ru can be retained in the glass. Experiments on retention of volatilized Ru in iron oxide-coated silicious bed material was conducted at bed temperatures of 500 to 800°C. Perchloric acid treatment of the bed material improved the retention efficiency of volatilized Ru on the order of 99.9%. Studies to form thermally stable compounds of Cs_2O with B_2O_3, TiO_2, and MoO_3 revealed that it was possible to supress Cs volatility appreciably with the above compounds. However, at a temperature in the range of 1100°C with actual glass mix, little effect was noted. Several empirical methods were studied to determine the corrosion of various alloys at high temperatures in glass melts. Among the six alloys studied Inconel-600 was found to be the most corrosion resistant with a corrosion rate of the order of 43 mill/month after 96 hours in molten glass at 1050°C and exhibited very little intercrystalline corrosion. A gas-fired pilot plant furnace for incorporating medium-level inorganic radioactive residual waste such as sludge and ashes in glass was proposed. Material handling techniques, gas cleaning studies, and economics of the process compared to asphalting and concreting are being studied for this process. (auth)

23095 (IN–1091) FIRST ZIRCONIUM ALLOYED FUEL REPROCESSING CAMPAIGN USING SOLUBLE NUCLEAR POISON. Offutt, G. F.; Wheeler, B. R. (Idaho Nuclear Corp., Idaho Falls). Mar. 1968. Contract AT(10-1)-1230. 75p. Dep. CFSTI.

Uranium was recovered at ICPP from high-enriched zirconium-alloyed fuels during FY 1965 to 1966 using a soluble neutron poison to guarantee nuclear safety. The use of boric acid in the hydrofluoric acid dissolvent made it possible to charge up to 17 kg of ^{235}U to a large semicontinuously operated dissolver and to achieve net processing rates up to ten times the maximum rate otherwise possible in this dissolver. Uranium recovery through the final extraction cycle averaged 99.5 percent, and product decontamination was excellent. Neptunium present in the zirconium fuels was separated and stored for future processing during the campaign instead of being discarded to the waste tank farm with second cycle raffinates as done previously. (auth)

23096 (INP–584/PL) SZYBKIE ROZDZIELANIE PIERWIASTKOW PROMIENIOTWORCZYCH METODA ODPAROWYWANIA W PROZNI. (Rapid Separation of Radioactive Elements by Evaporation in Vacuum). Gasior, Marian; Lizurej, Henryk I.; Niewodniczanski, Henryk; Potempa, Antoni W. (Institute of Nuclear Physics, Krakow (Poland)). Dec. 1967. 16p. (In Polish). Dep.

An apparatus and techniques are described for the rapid separation of radioactive elements from target material irradiated in a cyclotron. In order to choose the conditions the most suitable for separation a graph of the temperature dependence of the saturated vapor pressure of many elements is given. Some examples of the application of this method are also given. (auth)

23097 (INR-P-860/VIII/C) STUDY ON THE ANION EXCHANGE AFFINITY AND CHROMATOGRAPHIC SEPARATION OF THE RARE EARTH COMPLEXES WITH TRANS-1,2-DIAMINOCYCLOHEXANE-N,N'-TETRAACETIC ACID. Wodkiewixz, Ludmila; Dybczynski, Rajmund (Institute of Nuclear Research, Warsaw (Poland)). 1967. 21p. Dep.

Anion exchange behavior of the rare earth elements in the system: Dowex 1 × 4 [H_2Z^{2-}]–aqueous solution of disodium salt of trans-1,2-diaminocyclohexane-N,N'-tetraacetic acid /Na_2H_2Z/ has been studied. All the lanthanides, Sc and Y form complexes of the LnZ^- type at pH 4.8. Ion exchange affinity in the lanthanide series increases in a regular manner from lanthanum to promethium and then decreases with further increase of atomic number. Apparent atomic numbers of Sc and Y in this system are 64⅛ and 67⅛, respectively. Separation factors of adjacent lanthanides are substantially smaller than corresponding values for Dowex 1 × 4 [H_2Y^{2-}]–Na_2H_2Y aq. system when Y^{4-} stands for EDTA anion. Some separations however can still be achieved. Heights equivalent to a theoretical plate are greater than in the corresponding EDTA system, indicating that ion exchange kinetics in DCTA system is less favorable. (auth)

23098 (IS-1799) TANTALUM RECOVERY FROM $TaCl_5$–CaO AND $TaCl_5$–CaF_2 REACTION PRODUCTS USING CARBONYL CHLORIDE. Svoboda, W. N.; Stevenson, F. D. (Ames Lab., Iowa). Feb. 1968. Contract W-7405-eng-82. 22p. Dep. CFSTI.

The recovery of tantalum from the reaction products of $TaCl_5$ with calcium oxide and calcium fluoride has been studied using carbonyl chloride as a chlorination agent. Tantalum recoveries of up to 90% were achieved in each case. It was found, however, that recovery from CaO which had been predried at 900°C was limited to 66% whereas the higher recoveries were from "undried" CaO. The parameters of reaction time and $COCl_2$ concentration were investigated. (auth)

23099 (K-L-1780(Pt.23) ORGDP FUEL REPROCESSING STUDIES. Progress Report for Period Ending October 31, 1967. Pashley, J. H. (Oak Ridge Gaseous Diffusion Plant, Tenn.). Jan. 26, 1968. Contract W-7405-eng-26. 22p. Dep. CFSTI.

Additional oxidation runs were made in the semiworks plant to evaluate operating procedures for solid cylindrical pellets. Other component work during the report period included filter studies in the test loop with multicycle exposures to volatility process corrosive atmospheres, continued operation of the ORGDP peripheral compressor, and completion of the liquid bromine pentafluoride spill test program. Conceptual plant studies for low-enrichment fuel reprocessing include a study on the effects of bed diameter and depth on reactor throughput capacity and decontamination factors for ruthenium in the purification of plutonium based on the hazards associated with handling plutonium dioxide. (M.C.G.)

23100 (NP-17234) THE TREATMENT OF EUROCHEMIC MEDIUM LEVEL WASTE BY THE NEUTRALISATION SELF-SOLIDIFICATION PROCESS (N.S.S.P.). Hild, W.; Lopez-Menchero (European Company for the Chemical Processing of Irradiated Fuels, Mol (Belgium)). Nov. 1967. 31p. (ETR-219; CONF-671128-1). Dep.

From 37th International Congress of Industrial Chemistry, Madrid, Spain.

The different liquid effluents produced in the Eurochemic reprocessing plant are described. Emphasis is given to the particular medium-level waste (MLW) situation. Research and development work performed at Eurochemic on the MLW problem, leading to the neutralization self-solidification process (NSSP), is briefly summarized. A description of the patented MLW solidification process is given. Essentially the process consists of: a neutralization step, where the free H_2SO_4 containing MLW solutions are neutralized by lime ($Ca(OH)_2$ powder); a mixing and concentration step, where the neutralized waste streams are mixed with other MLW solutions and concentrated to a slurry of ≤10% humidity; a solidification and conditioning step, where the concentrated slurry is compressed into suitable blocks that set rapidly and while drying release the remaining water that is not chemically bound; and a coating and filling step, where the solid waste blocks receive an impermeable coating prior to sealing the storage containers. The NSSP is characterised as a low-temperature, wet, and economic MLW solidification process of great flexibility leading to average volume reduction factors of 4 to 5. Development work on the main units of equipment for a continuous process is summarized and the conclusions for a NSSP plant treating Eurochemic's Medium Level Waste are drawn, showing that at optimum capacity (1 m^3 MLW/h) waste treatment costs compare favorably with the costs for perpetual liquid storage. (auth)

23101 (ORNL-TM-1938) SUMMARY OF THE CAMPAIGN TO PROCESS FOUR PROTOTYPE HFIR TARGETS IN THE TRANSURANIUM PROCESSING PLANT. McDuffee, W. T.; King, L. J. (Oak Ridge National Lab., Tenn.). Apr. 1968. Contract W-7405-eng-26. 21p. Dep. CFSTI.

Four prototype HFIR targets, irradiated at the Savannah River Plant to 73% burnup of the 9.57 g of ^{242}Pu originally contained in each of them, were processed in the Transuranium Processing Plant (TRU) to recover the transuranium elements. Purified products contained about 9.2 g of ^{242}Pu, 8.8 g of ^{244}Cm, 130 μg of ^{252}Cf, and 30 μg of ^{249}Bk. This was the first campaign in TRU and it served to test the chemical flowsheets, processing equipment, and operating procedures for recovering transuranium elements from irradiated targets. Processing included dissolving the targets in nitric acid (with and without fluoride catalyst), recovering and purifying unburned plutonium using anion exchange (nitrate medium) and purifying transplutonium elements using the Tramex solvent extraction process, which features a tertiary amine as the extractant. Satisfactory results were obtained for each of these steps, but numerous minor changes were required in flowsheets, equipment, and procedures. Two attempts to demonstrate the Berkex process for separating and purifying berkelium were unsatisfactory; solids in the feed plugged equipment. (auth)

23102 SOLIDIFICATION OF RADIOACTIVE CONCENTRATES IN GLASSES OR CERAMICS. PART 3. STUDIES OF THE APPLICABILITY OF VOLCANITES FROM NATIVE DEPOSITS. Sachse, G.; Rosenberger, H. (Zentralinstitut fuer Kernphysik, Rossendorf, Ger. Institut fuer Angewandte Mineralogie, Dresden). Kernenergie, 11: 15-23(Jan. 1968). (In German).

The properties of basalts, phonoliths, decomposition products of basalt tuff, and pechstein from several deposits, experiments of producing low-melting silicate materials or glasses by introduction of inactive fractions, and experiments of leaching out the radioactive products are discussed. (auth)

23103 METHODS FOR STUDYING NATURAL PLUTONIUM. Zverev, V. L. Radiokhimiya, 10: 116-18(1968). (In Russian).

A brief review is given of various methods for ^{239}Pu separation. One effective method is radiochemical separation of ^{239}Pu by extraction using diethyl ether. Plutonium concentration in calcium oxalate was followed by extraction using tributyl phosphate. ^{239}Pu was separated from thorium isotopes on ion-exchange resins in hydrochloric acid media. Electrochemical precipitation was carried out with mixtures of 50 ml nitrate solution, 10 ml acetone, and 5 ml isopropanol with 1 hr of electrolysis with a current of 1.5 amf, 10 to 10 v, and at pH = 2. The maximum amount of ^{239}Pu (3.29 pulse/min) was separated from 50 g of limonite, which amounted to a 53% yield or 1.82×10^{-12} g/g ^{239}Pu. The weight ratio of Pu to U was 1.2×10^{-5} with a U content of 1.1×10^{-7} g/g. (R.V.J.)

23104 COPRECIPITATION OF SMALL AMOUNTS OF MOLYBDENUM, CHROMIUM, AND RHENIUM WITH METAL HYDROXIDES. Plotnikov, V. I.; Kochetkov, V. L. (Inst. of Physics, Alma-Ata, USSR). Zh. Anal. Khim., 23: 377-83(Mar. 1968). (In Russian).

The coprecipitation of small amounts of molybdenum, chromium, and rhenium with titanium, indium, aluminum, iron, zirconium, thorium, bismuth, lead, yttrium, cerium(IV), cadmium, and beryllium hydroxides was studied. The coprecipitation of molybdenum, chromium, and rhenium depended on the pH of the solution, the nature of the hydroxide and the precipitant, and on the order of solution addition. Small amounts of chromium(III) and chromium(VI) were separated by the selective coprecipitation of chromium(III) with titanium hydroxide. Chromium(VI) did not coprecipitate with titanium hydroxide at pH 8 and above. (auth)

23105 SEPARATION OF URANIUM(VI) AND URANIUM(IV) ON SULPHO CATION EXCHANGERS CONTAINING VARIOUS AMOUNTS OF DIVINYL BENZENE. Karalova, Z. K.; Shibaeva, N. P.; Pyzhova, Z. I. (Inst. of Geochemistry and Analytical Chemistry, Moscow). Zh. Anal. Khim., 23: 455-7(Mar. 1968). (In Russian).

Uranium(VI) and uranium(IV) were separated in a sulfuric acid solution using resins containing higher amounts of divinyl benzene (more than 14%). (auth)

23106 VOLATILITY PROCESSES. Barghusen, J. J. Reactor Fuel-Process. Technol., 11: 54-9(Winter 1967-68).

The nitrofluor process, the Aquafluor process, and the purification of UF_6 and PuF_6 are discussed. (M.C.G.)

23107 COMPACT PYROCHEMICAL PROCESSES. Miller, W. E.; Steunenberg, R. K. Reactor Fuel-Process. Technol., 11: 60-4(Winter 1967-68).

The salt-transport process for fast breeder reactor fuels is discussed. Processes for Molten-Salt Breeder Reactor fuel are described. (M.C.G.)

23108 RESEARCH AND DEVELOPMENT ON AQUEOUS PROCESSING. Stevenson, C. E.; Paige, D. M. Reactor Fuel-Process. Technol., 11: 49-53(Winter 1967-68).

Caustic decladding followed by nitric acid dissolution is favored as the feed preparation method for processing D_2O-moderated organic-cooled reactor fuels consisting of oxides or carbides clad in SAP. A preliminary study indicated the feasibility of processing stainless steel-clad oxide fuels from a fast breeder reactor in an existing commercial TBP process solvent-extraction plant. The chemistry and some process methods for transuranium elements are reviewed. Design and operation of hydroclones are discussed. (M.C.G.)

23109 PROGRESS IN WASTE-DISPOSAL RESEARCH AND DEVELOPMENT. Fineman, Phillip. Reactor Fuel-Process. Technol., 11: 65-8(Winter 1967-68).

Conversion of high-level-activity wastes to solids by fluid-bed calcination is discussed. Possible modifications to the Waste Calcining Facility to improve its operating reliability and increase its through-put rates are considered. Feed injection of waste solutions into fluidized beds in the Waste Calcining Facility is described. Asphalt immobilization of intermediate-level-activity wastes is discussed. (M.C.G.)

23110 FLUID BED DENITRATION OF THORIUM NITRATE. Robertson, Wilbert J.; Kerr, Gerrald E. (to United States Atomic Energy Commission). U. S. Patent 3,376,116. Apr. 2, 1968.

A process for the thermal denitration of thorium nitrate in a fluid bed reactor was developed. Thorium nitrate is sprayed on a heated fluidized bed of dense, high-fired thorium dioxide. (AEC)

23111 CHROMATOGRAPHIC SEPARATION OF ^{95}Nb-^{95}Zr (IN HYDROFLUORIC ACID MEDIUM) WITH NITRATE-BUTANOL. Archundia, C.; Ajuria, S. (Comision Nacional de Energia Nuclear, Mexico City). Rev. Soc. Quim. Mex., 10: 77-8(1966). (In Spanish).

The solution of ^{95}Zr and ^{95}Nb in HF was subjected to ascending-solvent paper chromatography by development with various mixtures of an aqueous nitrate solution, HNO_3 and butanol. The best results were obtained with a mixture (1:4) of 7M $LiNO_3$, 2M HNO_3, and butanol. Other alkali metal nitrates were effective, but nitrates of Ca or Sr were less so, and $Al(NO_3)_3$ was ineffective. (Anal. Abstr.)

23112 ISOLATION OF ^{233}U FROM IRRADIATED THORIUM OXIDE. AN AMINE EXTRACTION PROCEDURE. Ishimori, Tomitaro; Kimura, Kan; Ono, Reiko (Japan Atomic Energy Research Inst., Ibaraki). J. Nucl. Sci. Technol. (Tokyo), 5: 39(Jan. 1968).

Thorium oxide was irradiated for 99 hr at a neutron flux of 2×10^{12} n/cm^2/sec, and allowed to stand for 3.5 yr. Gamma activity was thus low enough to permit handling without special shielding. ^{233}U was extracted with triisooctylamine in xylene, and determined by mass spectrometry in combination with the isotope dilution technique. Results indicated the main component to be ^{233}U contaminated with natural uranium. (J.G.B.)

23113 SEPARATION OF STRONTIUM FROM CALCIUM AND MAGNESIUM BY ION-EXCHANGE CHROMATOGRAPHY [IN ANALYSIS OF SEA-WATER]. Sednev, M. P.; Starobinets, G. L.; Akulovich, A. M. (Belorussian State Univ., Minsk). Zh. Anal. Khim., 21: 23-7(1966). (In Russian).

A study was made on the distribution of Mg, Ca, and Sr between Dowex 50 and KU-2 cationites (Na^+ form) and EDTA solution. The Ca and Mg pass through the column almost together, and are eluted with 0.01M EDTA of pH 5.4. The elution of Sr^{2+} from the column is then carried out with 0.01M EDTA of pH 11.5 to 12. The method was used for isolating Sr from large volumes (30 to 50 liters) of seawater. (Analytical Abstr. No. 9, 1967)

23114 ANALYTICAL CHEMISTRY OF THE TRANSURANIUM ELEMENTS. Korkisch, J. (Univ., Vienna). Oesterr. Chem.-Ztg., 67: 273-9(1966). (In German).

A discussion is presented of methods for the separation of the transuranium elements, including cation exchange on Dowex 50, anion exchange on Dowex 1 of the nitrate, chloride, or thiocyanate complexes, solvent extraction with 2-thenoyltrifluoroacetone, tributylphosphate, trioctylphosphine oxide or isobutyl methyl ketone, and precipitation with IO_3^-, F^-, oxalate, or PO_4^{3-}. The elements can be determined by titrating potentiometrically, amperometrically, spectrophotometrically, or with EDTA or Ce(IV) solutions. (Analytical Abstr. No. 12, 1967)

23115 INORGANIC THIN-LAYER CHROMATOGRAPHY. PART II. CHROMATOGRAPHY OF SOME FIRST ROW TRANSITION METALS ON THIN LAYERS OF SUBSTRATES IMPREGNATED WITH TRIBUTYL PHOSPHATE. Bark, L. S.; Duncan, G.; Graham, R. J. T. (Royal Coll. of Advanced Tech., Salford, Eng.). Analyst, 92: 31-5(Jan. 1967).

Several metal ions were chromatographed on thin layers of cellulose and silica gel impregnated with tributyl phosphate at different concentrations of hydrochloric acid. The open nature of the cellulose results in the tributyl phosphate being held more firmly on this substrate than on the silica gel, and this in turn results in lower R_F values. The R_F values of the metal ions are also shown to vary with the concentration of the hydrochloric acid eluent. (auth) (UK)

23116 STANDARD ADDITION FOR YIELD DETERMINATION IN RADIOCHEMICAL SEPARATION BY SOLVENT EXTRACTION. Alian, A. (Atomic Energy Establishment, Cairo). Mikrochim. Acta, No. 2, 368-70(1968).

A procedure is described for the determination of yields in radiochemical separation by solvent extraction. Selective extraction of the test radionuclide is coupled with the standard addition method. (auth)

23117 SEPARATION OF ZIRCONIUM AND HAFNIUM AND PREPARATION OF HAFNIUM DIOXIDE BY THE METHOD OF SELECTIVE RODANIDE EXTRACTION WITH ETHYL ACETATE. Vinarov, I. V.; Gertsenshtein, E. Sh.; Byk, G. I.; Kovaleva, E. I. (Odessa Inst. of General and Inorganic Chemistry). Ukr. Khim. Zh., 34: 153-5(1968). (In Russian).

Distribution coefficients and separation factors were determined for zirconium and hafnium thiocyanates extracted from sulfuric acid solutions. A method is suggested for separation of Zr and Hf technical mixtures and for preparation of Hf oxides by selective thiocyanate extraction with ethyl acetate. The method was used for separating a large amount of HfO_2 from concentrates. (R.V.J.)

23118 SEPARATION OF ^{22}Na AND ^{24}Mg BY ION EXCHANGE ON KY-2 RESIN. Bliznyukova, V. A.; Krotenko, A. P. (Inst. of Physics, Kiev). Ukr. Khim. Zh., 34: 156-7(1968). (In Russian).

A method is described for separating carrier-free ^{22}Na and ^{24}Mg at a rate of 0.04 to 0.06 ml/cm^2/min using KU-2 resin. A graph is given of the ^{22}Na separation as a function of the volumes of 0.1N hydrochloric acid. (R.V.J.)

23119 EXTRACTION OF METALS BY TRIBUTYLPHOSPHATE IN THE FORM OF THEIR SULPHATE COMPLEXES. Zharovskii, F. G.; Vyazovskaya, L. M.; Kostova, R. V. (Kiev State Univ.). Ukr. Khim. Zh., 34: 181-5(1968). (In Russian).

The extraction of Mo, V, Fe, Nb, Ta, Zr, and Ti sulfate complexes by 30% TBP in carbon tetrachloride solution was studied. It was found that V^{5+}, Nb^{5+}, Ta^{5+}, Mo^{6+}, Fe^{3+}, Zr^{4+}, and Ti are extracted from 12.5 moles of sulfuric acid in the following order 12, 30, 44, 11, 19, 79, and 99%, respectively. Tabulated data are given for the TBP extraction of sulfate complexes of metals (Cu, Al, Ti, Zr, Zr + Hf, Hf, Sn, Ce, V, As, Bi, Nb, Ta, Pa, Cr, Mo, W, U, Mn, Np, Fe, Co, and Ni) considering the acidity and composition of the aqueous phase and the properties of the diluent. (R.V.J.)

23120 UTILIZATION OF α-HYDROXYISOBUTYRIC ACID AS AN ELUENT IN THE ION-EXCHANGE SEPARATION OF PROMETHIUM AND NEODYMIUM. Mikhailova, Vera. Izv. Fiz. Inst. Aneb, Bulg. Akad. Nauk., 16: 111-16(1967). (In Bulgarian).

The separation of promethium without carrier from a 100-mg target of neodymium oxide irradiated with thermal neutrons was carried out by using a cation-exchange resin and a buffer solution of α-hydroxyisobutyric acid as eluent in a single run. The yield of promethium obtained is 98.7% and the contamination of neodymium is under 0.01%. (auth)

23121 REPROCESSING OF REACTOR FUEL ELEMENTS. Tjaellidin, O. (to Swedish Atomic Energy Co.). Swedish Patent 211,087. Feb. 21, 1967. Filed Jan. 18, 1961. (In Swedish).

A method is described for treatment of spent nuclear reactor fuels. The fuel elements consist of UO_2 and are cladded with Zr. The cladding material is oxidized by a mixture of steam, O_2 (less or equal to 30%), and N_2 (40 to 90%) at about 800°C. The UO_2 is oxidized to U_3O_8 at 300 to 600°C with O_2 containing small amounts of steam and N_2. It is then leached selectively with 4 to 4.5M HNO_3. The acid does not solve the oxidized cladding material. (Sweden)

23122 RADIOAKTIVE ABFAELLE. AUFBEREITUNG, LAGERUNG, AND BESEITIGUNG. (Radioactive Wastes. Treatment, Storage, and Disposal). Krawczynski, Stefan J. B. Thiemig-Taschenbuecher, Band 27. Munich, Verlag Karl Thiemig KG, 1967. 312p.

The collection, processing, and storage of radioactive waste has become one of the principal problems of nuclear technology. The techniques selected for the collection, processing, and storage must find a compromise between safety, economy, and future development. In the present study a comprehensive review is made of this problem. The most important methods used presently in the processing and storage of radioactive waste are described. Suggestions are made for the future development and research in this area. (J.S.R.)

23123 METHOD AND APPARATUS FOR THE ELECTRONIC REGULATION OF A PLUTONIUM EXTRACTION BATTERY. Degryse, M.; Riolfo, R. (to Commissariat a l'Energie Atomique). Canadian Patent 778,083. Feb. 13, 1968. Priority date June 29, 1965, France.

A method for extracting Pu from spent fuels is described in which nearly total purification can be obtained in a single step. BF_3 detectors together with other electronic equipment control the solvent extraction process with tributyl phosphate. A flow sheet is drawn up but not the circuitry. (F.S.A.)

23124 METHOD OF SEPARATION OF RADIUM. Kremer, M. (to Commissariat a l'Energie Atomique). Canadian Patent 778,831. Feb. 20, 1968. Priority date May 28, 1963, France.

Ba^{2+} ions from $BaCl_2$ solution were added to the effluent containing SO_4^{2-} ions from the treatment of uranium ores. A solution of the sodium salt of a straight-chain fatty acid having 15 to 18 carbon atoms was also added. The mixed insoluble sulphates of Ba and Ra and the insoluble fatty acid formed an agglomerate of large flakes which settled readily. The supernatant liquid, which may be decanted off, contained only about 2×10^{-12} Ci/l. Concentration of the soap solution must be so chosen that precipitation and not flotation occurs. (F.S.A) (Canada)

23125 PROCESS FOR REPROCESSING NUCLEAR FUELS. Wurm, Joseph Gerard; Avogardro, Alessandro (to European Atomic Energy Community). British Patent 1,108,042. Mar. 27, 1968. Priority date June 10, 1964, Germany.

As a preliminary step in the reprocessing of fuel elements made up primarily of UO_2, the element is oxidized to convert all U compounds to the oxides and is cut into pieces. The cut and oxidized fuel is digested in a molten basic alkali metal compound in the presence of an oxidizing agent to convert the fuel into an alkali metal uranate in powder form that is insoluble in the melt and that can be readily removed. After removal of the uranate, the melt is treated with Al_2O_3, SiO_2, or other oxide-containing compound to convert fission products dissolved in the melt to a water-insoluble readily handleable cement-like form of solid waste. The alkali metal uranate is converted into a uranyl salt and UO_2 by melting in one of the following: aluminum halogenide, aluminum sulfate, alkali metal hydrogen sulfate, alkali metal pyrosulfate, or a mixture of these. (B.L.M.)

23126 SEPARATION OF TRIVALENT 4f RARE EARTHS FROM MOLTEN FLUORIDE COMPOSITIONS WITH UF_3. McDuffie, H. F. (to United States Atomic Energy Commission). U. S. Patent 3,379,648. Apr. 23, 1968.

A method for separating 4f rare earth trifluorides from a molten fluoride composition was developed. UF_3 is added to the molten fluoride to form a saturated solution of UF_3. UF_3 is precipitated from the solution, and the resulting precipitate separated. (AEC)

23127 PROCESS FOR EXTRACTION OF POLONIUM. Cimetiere, Claudette; Desroches, Jean; Routier, Claude (to Commissariat a l'Energie Atomique). British Patent 1,109,016. Apr. 10, 1968. Priority date Mar. 17, 1965, France.

A method for the separation of Po from Bi consists of dissolving the mixture in a strong mineral acid, preferably 0.5 to 2N HNO_3, contacting the acid solution with activated charcoal to adsorb the Po, and then desorbing the Po from the charcoal. The desorption of Po can be carried out by grinding the activated charcoal to a particle diameter of between 500 and 2000 μ oxidizing the charcoal with concentrated HNO_3, contacting the charcoal with metallic Ag in a solution of 1N HCl, or by washing the charcoal with a 5 to 7N HNO_3 solution. (B.L.M.)

EARTH SCIENCES

Geology and Hydrology

Refer also to abstracts 23163, 23165, 23176, 23185, and 23250.

23128 (A/AC.82/G/L-1175) O VLIYANII PRIRODNYKH USLOVII NA SODERZHANIE I RASPREDELENIE RADIOAKTIVNOGO STRONTSIYA V POCHVENNOM POKROVE. (The Influence of Natural Conditions on the Content and Distribution of Radioactive Strontium in the Soil Cover). Pavlotskaya, F. I.; Tyuryukanova, E. B. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow). 1967. 16p. (In Russian). Dep.

The content of radioactive strontium in the soil cover, apart from the level of its influx from the atmosphere, depends on the type of soil, the form of vegetation, the hydrometeorological conditions, the geomorphological composition of the area, and other natural factors. The latter explains to a significant degree the irregular character of the distribution in the landscape. The rate of accumulation of ^{90}Sr in the soil cover at different depths (up to 20 cm) during 1960 to 1963 was on an average 20 to 30% lower than its accumulation rate on the earth's surface, which indicates its erosion from the surface level. On an average the content of ^{90}Sr in the soil cover in 1960 to 1963 increased by 2. The latitudinal character of its distribution on the earth's surface continued to be maintained. During the selection of samples of soil cover for evaluation of its level of contamination and for investigation of the character of the distribution on and uptake by the soil, it is necessary to take into account the landscape-geochemical characteristics of the territory studied. (tr-auth)

23129 (A/AC.82/G/L-1176) RASPREDELENIE RADIOAKTIVNOGO STRONTSIYA V POCHVAKH RAZLICHNYKH PRIRODNYKH ZON. (Distribution of Radioactive Strontium in the Soils of Different Natural Zones). Tyuryukanova, E. B.; Pavlotskaya, F. I.; Baranov, V. I. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow). 1967. 16p. (In Russian). Dep.

The distribution of ^{90}Sr in the soil-vegetation cover was determined, together with content of this isotope in fallout, by a complete series of natural factors, among which the most significant are the type of soil and the geomorphological and hydrometeorological conditions. ^{90}Sr is most stably bound in soils with high humus content and with heavy mechanical composition. In bottom soils a high mobility of the ^{90}Sr was observed. The discrepancy in the behavior of stable and radioactive Sr in years with a high level of precipitation is explained both by the different sources and forms of its inflow to the soil and by the different times of interaction. The vertical migration of radiostrontium depends on the genetic structure of the soil. ^{90}Sr is impeded in humus levels, washed out through podzolic levels, and bound in alluvial levels. (tr-auth)

23130 (CONF-660329) A SYMPOSIUM ON GEOLOGY OF CEMENT RAW MATERIALS, BLOOMINGTON, INDIANA, MARCH 31–APRIL 1, 1966. Proceedings of the Second Forum on Geology of Industrial Minerals. (Indiana Geological Survey, Bloomington. Indiana Univ., Bloomington. Dept. of Geology). 197p.

Sixteen papers were presented at the conference. Fifteen papers on the geology, availability, and properties of cement raw materials were not within scope of NSA. One paper on the radioactivity of cement raw materials was previously included in NSA. For an abstract of this paper see CONF-660329 in the Report Number Index. (R.C.K.)

23131 (CONF-680112-1) USE OF NUCLEAR ENERGY IN WATER STUDIES FOR INCREASING AGRICULTURAL PRODUCTIVITY. Kirkham, Don (Iowa State Univ. of Science and Technology, Ames). Jan. 9, 1968. 62p. Dep. CFSTI.

From Conference on the Application of Nuclear Energy to Agricultural Productivity, Santiago, Chile.

Particles and rays used primarily in water studies are neutrons, gamma rays and beta particles. Neutrons are used to measure moisture in the soil. Gamma rays and beta particles are emitted from isotopes of hydrogen, carbon, nitrogen, oxygen, phosphorus, chlorine and potassium and are being used in water studies. Infiltration into and evaporation of moisture from soil, ground water development, times of flow in waterways, water erosion, transport of plant nutrients in ground water, desalination of sea water, and nuclear explosives for agricultural water works are discussed. The neutron soil moisture meter is probably the most widely used nuclear energy device in water studies in agriculture. The moisture meter permits continuous following of soil moisture at a given site without disturbing the soil except for an initial installation of an access-tube for the meter. From neutron soil moisture meter measurements, practical recommendations related to water use, such as planting density of farm crops and application of irrigation water are now being made. (auth)

23132 (DPST-67-457) SUMMARY REPORT ON THE GEOLOGY AND HYDROLOGY OF THE 100 AND 200 AREAS AT SAVANNAH RIVER PLANT FOR THE PERIOD 1961–1966. Reichert, S. O. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). July 1967. Contract AT(07-2)-1. 52p. Dep. CFSTI.

The results of measuring monthly the water level elevation of wells in the 100 and 200 areas are summarized. The lithology by 10-ft increments of depth below the ground surface of drill holes in the 200 areas, and of logs of drill holes in the 100 areas that were used for water level measurements is recorded. From these data, contour maps drawn on the top of the free water table in each area show the highest elevation free water table during the 1961-1966 period, the depth to the water table at the highest elevation water table, and the lowest water table elevation. (J.C.W.)

23133 (IA-1128, pp 156-9) ENVIRONMENTAL STUDIES. (Israel Atomic Energy Commission, Tel Aviv).

Measurements of radioactive fallout during 1966 are reported. Measurements were made of gross beta activity, ^{137}Cs and ^{90}Sr content in fallout, and in some cases, gamma activity. Representative foods which make up the Israeli diet were collected and analyzed for ^{137}Cs and ^{90}Sr, radioactivity in the IAEA "mixed diet" was assayed. Fission product hazards in nuclear reactor environments were evaluated. An analytical solution for the turbulent diffusion from an instantaneous plane source was derived. The maximum value of Suttons' equation for deposition was corrected. (R.C.K.)

23134 (SC-RR-65-179) SCIT: A COMPUTER PROGRAM FOR STATE OF STRESS IN AN EARTH TARGET. Kitzinger, David G.; Hultgren, Ronald O. (Sandia Corp., Albuquerque, N. Mex.). July 1965. Contract AT(29-1)-789. 6p. Dep. CFSTI.

Supplement to SC-RR-64-1734.

SCIT is a digital computer program which permits the calculation of stress levels at numerous points within an elastic target having arbitrary properties and resting on a rigid base. Principal stresses, their directions, and edge deflections are calculated. Shapes considered include rectangular, triangular, and trapezoidal cross-sections having arbitrary dimensions. (auth)

23135 (STI/PUB-158) ISOTOPE AND RADIATION TECHNIQUES IN SOIL PHYSICS AND IRRIGATION STUDIES. Proceedings Series. Proceedings of a Symposium held in Istanbul, 12-16 June 1967. (International Atomic Energy Agency, Vienna (Austria)). 1967. 446p. (CONF-670641). IAEA: $9.00; S 233,-; £3.3.6; F Fr 44,10; DM 36,-.

Thirty-one papers on isotope and radiation techniques used in soil physics and irrigation studies are presented. Separate abstracts were prepared for 29. One paper appeared in NSA previously. For an abstract of this see CONF-670641 in the Report Number Index. (L.C.L.)

For abstracts of individual papers see: 23143–23145, 23147–23162, 23204, 23205, and 23346–23353.

23136 NUCLEAR LOGGING METHODS. Caldwell, Richard L. (Mobil Research and Development Corp., Dallas). Radioisotopes (Tokyo), 17: 171-85(Apr. 1968).

New developments in nuclear logging methods with special emphasis on industrial uses were surveyed. The use of natural gamma logs to give rock lithology, gamma ray scattering to give density information and to locate concentrations of heavy elements in rocks, neutron logs for porosity determinations and oil-salt water differentiations, and combinations of logs to identify lithology and deposits of nonmetallic minerals are discussed. Future nuclear logging techniques for lunar and planetary surface analysis, as a gage for ocean bottom sediment density, and for photonuclear activation of geologic samples are suggested. Computer methods for the analysis of complex gamma spectra are also discussed. (17 references) (J.G.B.)

23137 REFERENCE FOR DETERMINING THE ISOTOPIC COMPOSITION OF THORIUM IN CRUSTAL ROCKS. Rosholt, J. N. Jr.; Peterman, Z. E.; Bartel, A. U. S. Geol. Surv., Prof. Pap., 575-B, B133-6(1967).

A naturally occurring reference sample was obtained that is believed to be in radioactive equilibrium and to have a U/Th ratio similar to that of most crustal rocks. The reference sample is used to compare the $^{230}Th/^{232}Th$ activity ratios determined in crustal rocks and to establish the condition of radioactive equilibrium of $^{230}Th/^{238}Th$ or ^{230}Th to ^{234}U in these rocks, on the basis of their $^{230}Th/^{232}Th$ and $^{238}U/^{232}Th$ content. The natural reference sample is a portion of a drill core from a depth of 7,300 ft, about 80 ft below the top of the Precambrian basement complex, in southwestern Saskatchewan, Canada. The rock, a porphyritic biotite granite, contains 24.1 ± 0.2 ppM of U and 82.8 ± 0.9 ppM of Th. (auth)

23138 THE PROBLEM OF THE CONTAMINATION OF THE RHINE WITH RADIOACTIVE NUCLIDES. Block, Wolfram; Schneider, Horst (Isotopenlaboratorium der Bundesanstalt fuer Gewaesserkunde, Koblenz, Ger.). Gas- Wasserfach, 108: 149-57(Nov. 3, 1967). (In German).

The uptake of several radionuclides by living and dead cultures of the alga A. falcatus was compared. In live cultures the greatest uptake was observed with ^{32}P, ^{65}Zn, and ^{137}Cs. The uptake of these radioisotopes amounted to ~10 fold that of ^{85}Sr, ^{239}Pu, and ^{131}I. In dead algae ^{65}Zn was observed to have the greatest uptake as compared with the other radionuclides studied. The radioisotopes were observed to be retained for relatively long periods of time, and turnover appeared to be relatively slow. This was found to be true for either living or dead cultures of the algae. This finding contrasted with previous reports, which have presented conflicting values for the retention of the radioisotopes used. It is suggested that other varieties of algae may have retention characteristics that differ from those reported. (BBB)

23139 EVALUATION OF THORON EXHALATION. Sen'ko, E. E.; Starikov, B. G. Izv. Akad. Nauk SSSR, Fiz. Atmos. Okeana, 4: 367-8(Mar. 1968). (In Russian).

A simplified method is suggested for evaluating the amount of thoron exhalation under various local soil conditions. The thoron exhalation method is based on the measurement of radon and thoron concentrations in soils and exhalation of the radon. The results are analyzed and compared with results from other methods. (R.V.J.)

23140 POINT DILUTION METHODS OF INVESTIGATING GROUND WATER FLOW BY MEANS OF RADIOISOTOPES. Drost, Walter; Klotz, Dietmar; Koch, Arnd; Moser, Heribert; Neumaier, Ferdinand; Rauert, Werner (Institut fuer Radiohydrometrie, Munich). Water Resour. Res., 4: 125-46(Feb. 1968).

Models for use with the point dilution method of measuring the flow rate of ground water carried out with radioisotopes are considered. To apply the point-dilution method of measuring the rate of ground water flow by radioactive tracers, the distortion of the flow field by the well must be known. The distortion can be calculated with sufficient accuracy if the permeabilities of the aquifer, k_3, of the gravel pack, k_2, and of the well screen, k_1, fulfill the condition $k_3 \leq k_2 \leq k_1$. The radioisotope must be adequately mixed during the dilution procedure. Experiences obtained from model tests were applied to field investigations. By using peak-to-peak and total count methods in wells where vertical flow occurred, it was possible to determine the depths and the rates of inflow and outflow which relate to seepage under dams and water exploration. To determine the direction of ground water flow, a radioactive tracer was injected into a well-screen section and, after having left the well-screen, was detected by a collimated detector. The use of radioisotopes that are fixed on the soil is advisable; ^{198}Au, having been homogeneously distributed within the dilution volume initially, proved most suitable. Strong vertical currents in the well represent a serious obstacle in field measurements of the rate and of the direction of ground water flow. (BBB)

23141 RADIOCARBON DATES FROM ALTONIAN AND TWOCREEKAN DEPOSITS AT SYCAMORE, ILLINOIS. Kempton, John P. (Illinois State Geological Survey, Urbana). Trans. Ill. State Acad. Sci., 59: No. 1, 39-42(1966).

Two radiocarbon dates were determined for wood collected from an exposure in a gravel pit in the valley of East Branch Kishwaukee River at the northern edge of Sycamore, Illinois. Wood chips in the lower part of the exposure collected from pinkish gray outwash, part of the youngest drift of the Altonian Substage, were dated as older than 32,000 years B.P. (W-1382). A log near the top of the exposure in a lenticular black organic silt deposited during the Twocreekan Substage was dated at 12,000 ± 400 radiocarbon years B.P. (W-1385). (auth)

23142 MOVEMENT OF RADIOACTIVE SODIUM AND RUTHENIUM THROUGH A SIMULATED AQUIFER. Champlin, J. B. F.; Eichholz, G. G. (Georgia Inst. of Tech., Atlanta). Water Resour. Res., 4: 147-58(Feb. 1968).

Factors affecting the presence of measurable quantities of radioisotopes in ground water, which has passed through a large thickness of soil or porous rock, in locations where radioactive wastes are stored were studied. To investigate the contribution made by water to the transport of ionic materials through soils, radioactive solutions were injected into a model aquifer containing 725 kg of sand with dimensions of 1 × 2 × 0.25 m. As the radioactivity passed through the sand, its progress was followed by a collimated G–M tube situated on the exterior of the bed. The appearance of the radioactivity in the effluent, which marked the arrival of the Na front, was found to be correlated with an increase in suspended particulate matter, K, and Ca concentrations, and overall conductivity. Of particular significance was that portion of the radioactivity shown to be related directly to the filterable mass of particles in the effluent, despite the high solubility of the ion used. The results with Na were compared with those of similar tests on the movement of trivalent Ru, which is not soluble at the pH of the solutions used. Both the Na and Ru studies indicated that a significant amount of radioactivity was transported through the test bed on particulate matter which was large enough to be trapped on 0.45-μ membrane filters. (BBB)

23143 GAMMA-RAY ATTENUATION FOR SOIL–WATER-CONTENT MEASUREMENTS USING ^{241}Am. King, L. G. (Battelle Memorial Inst., Richland, Wash.). Contract AT(45-1)-1830. pp 17-29 of Isotope and Radiation Techniques in Soil Physics and Irrigation Studies. Vienna, International Atomic Energy Agency, 1967.

From Symposium on the Use of Isotope and Radiation Techniques in Soil Physics and Irrigation Studies, Istanbul. See STI/PUB-158; CONF-670641.

For several years, soil–water content has been measured by the attenuation of gamma radiation, both on laboratory samples and in the field. Usually, ^{137}Cs has been used as the radioactive source emitting the gamma rays. The use of ^{241}Am as the source for such measurements is described, as well as some advantages for using ^{241}Am instead of ^{137}Cs, and the necessary precautions for the design of counting equipment. Both isotopes have the desired property of emitting nearly monoenergetic photons. The spectrum for ^{137}Cs shows a major peak at about 662 keV while for ^{241}Am, the peak occurs at 60 keV. Thus, the less energetic ^{241}Am source requires substantially less shielding for operator safety than does ^{137}Cs. The apparatus can be made smaller, lighter, and less costly; especially if it is desired to traverse the sample with a moving source and detector. The mass absorption coefficient for water is about 0.086 with ^{137}Cs and about 0.20 with ^{241}Am. The optimum thickness for best precision in gamma-ray attenuation techniques is between 1 and 3 half-thicknesses, with preference towards the upper value. Since, for water content measurements, we are primarily interested in the differences in overall densities between saturated and dry soil, the effective half-thickness for water as it exists in the pores of the soil is an important value. For similar soil conditions, the optimum thickness of water in the soil sample is about 2.3 times greater for ^{137}Cs than for ^{241}Am. Thus, if the optimum thickness for ^{137}Cs is 14 cm, the best thickness for ^{241}Am is only 6 cm. For the smaller samples there is greater sensitivity using ^{241}Am. Some precautions must be taken to ensure good counting efficiency for the less energetic ^{241}Am source. The system used in this study included a 1-mm-thick NaI(Tl) crystal coupled to an EMI 9536B photomultiplier tube. The signal from the tube was passed through a special preamplification section with gain of 20 before being fed to the preamplifier section of the RIDL scaler and timer. Data are presented showing the comparison of soil–water content measured volumetrically with the content determined by attenuation of gamma rays from ^{241}Am. The sample was contained in a small cell where the moisture content was controlled by controlling the capillary pressure. The water was extracted through a saturated porous material and measured in a calibrated horizontal tube. (auth)

23144 USE OF INFORMATION OBTAINABLE FROM A THERMALIZED NEUTRON FLUX AND POSSIBLE APPLICATIONS TO SOIL- AND MOISTURE-DENSITY MEASUREMENTS. Corompt, E. P.; Calmels, P. (Centre d'Etudes Nucleaires, Grenoble, France). pp 49-66 of Isotope and Radiation Techniques in Soil Physics and Irrigation Studies. Vienna, International Atomic Energy Agency, 1967. (In French).

From Symposium on the Use of Isotope and Radiation Techniques in Soil Physics and Irrigation Studies, Istanbul. See STI/PUB-158; CONF-670641.

The deceleration time of a fast neutron of specific initial energy, its "lifetime" in the thermal state and the length of its path through the moderating medium depend solely on the type and number of atomic nuclei which it encounters. The cloud of moderated neutrons surrounding the source contains all the information on the composition of the decelerating medium collected by

each neutron, and certain features of this cloud can be used to establish the composition of the medium. This applies particularly to the hydrogen content, dry density and chemical composition of a soil, which act simultaneously on the spatial and energy distributions of the neutron cloud. Information is normally taken only from the density of the thermal neutron cloud, in order to measure the hydrogen content of the soil. This measurement has to be corrected by measuring the dry-soil density by gamma diffusion, but this method is incomplete since it makes no allowance for the influence of the soil's chemical composition. A method using three flux intensity measurements: one of epithermal neutrons close to the source and two of thermal neutrons—one close to the source and the other at a distance of 10 cm—is proposed. Each of these measurements, made with a small-volume detector, provides different information on the hydrogen content, dry density and chemical composition of the soil. Some experimental tests offer hope that a combination of these three results could, after preliminary calibration, be used to establish the water content and dry density of soils of unknown chemical composition. A manner of presenting the results is described. Where the nature of the soil is known, the method can be used, with only one thermal neutron and one epithermal neutron measurement for determining the dry density and water content of the soil. This process obviates the need for the density correction measurement obtained by gamma diffusion. (auth)

23145 GAMMA-RAY AND NEUTRON ATTENUATION IN MEASUREMENT OF SOIL BULK DENSITY AND WATER CONTENT. Gardner, W. H.; Calissendorff, C. (Washington State Univ., Pullman). pp 101-12 of Isotope and Radiation Techniques in Soil Physics and Irrigation Studies. Vienna, International Atomic Energy Agency, 1967.

From Symposium on the Use of Isotope and Radiation Techniques in Soil Physics and Irrigation Studies, Istanbul. See STI/PUB-158; CONF-670641.

Use of gamma-ray attenuation measurements for obtaining nondestructive water-content and bulk-density measurements with high resolution and precision in experimental laboratory columns has long been possible. Thermal neutrons used in place of gamma-rays at fluxes available at a nuclear reactor make possible about tenfold improvement in the precision of water-content measurements for the same count-rate. Concurrent measurements using two different gamma-ray energies or gamma-rays and thermal neutrons make it possible to infer both soil bulk-density and water-content, thus increasing flexibility in experimental studies of water flow as affected by various soil factors. The limiting factor in both bulk-density and water-content measurement is the random emission of gammas or neutrons. Standard deviation for both types of radioactive emission is the square root of the number of disintegrations. Based upon random emission only, the precision (standard deviation) for both water content and bulk density is about ±0.006 g/cm^3 for an experimental set-up with 10^6 counts through air at the position where the soil column would be placed. For a 10-cm soil column with the measurement being made in a lamina 1 mm × 1 cm and for 1 min counting a gamma-ray source of about 300 mCi is required. At the Washington State University Nuclear Reactor Facility this count is achieved in about 0.5 min. Precision may be increased by increasing the counting rate, the increase being proportional to the square root of the ratio of the old to new counting rate. For example, increasing the counting rate by a factor of 4 by increasing slit size or lengthening counting time increases the precision by a factor of $1/\sqrt{4} = 1/2$. Other factors involved in precision and resolution are column width, collimator slit width, variation in mass attenuation coefficients of the mineral substances involved, and undetected changes in bulk density. (auth)

23146 ABSOLUTE ABUNDANCE AND DISTRIBUTION OF Rb, K, AND Sr IN THE EARTH. Hurley, Patrick M. (Massachusetts Inst. of Tech., Cambridge). Geochim. Cosmochim. Acta, 32: 273-83(Mar. 1968).

It was found that in 10^{25} metric ton units the earth contains 800 of K, 2.3 of Rb, and 70 of Sr. The concentration of these minor elements into the crust (and atmosphere-ocean system), relative to the earth as a whole, is consistent with their geochemical properties. The concentration of Rb is 45%, K 31%, and Sr 13%. The mean $^{87}Sr:^{86}Sr$ value in the crust is 0.7090, and in the mantle 0.7035. The radiogenic ^{87}Sr amounts to 950×10^{19} tons in the crust and 3020×10^{19} tons in the mantle. In order to develop the radiogenic ^{87}Sr in the present mantle and crust it is necessary that the trace elements of the crust shoud have separated continuously at a rather uniform rate, starting at about 3400×10^6 yr; a single stage early separation is not possible. The relative abundance of Sr in the total earth is found to be almost exactly equal to that in chondrites. The loss of K in the earth relative to chondrites is very nearly the same as the loss of Rb, namely about 0.15; the K:Rb ratio is similar to that in chondrites. The known percentage concentration of these key elements into the crust allows an estimate of the concentration of other elements such as U, Th and the lanthanide group, through their known behavior as ratios in various rock types. This information leads to their relative abundance in the earth as a whole. It is found that the less volatile elements closely equal their chondrite abundances adding substantial support to the chondrite model. (auth)

23147 CHANGES IN THE MOISTURE OF A SOIL CONTINUOUSLY IRRIGATED OVER A SMALL SURFACE. Rancon, D. (Centre d'Etudes Nucleaires, Cadarache, France). pp 125-35 of Isotope and Radiation Techniques in Soil Physics and Irrigation Studies. Vienna, International Atomic Energy Agency, 1967. (In French).

From Symposium on the Use of Isotope and Radiation Techniques in Soil Physics and Irrigation Studies, Istanbul. See STI/PUB-158; CONF-670641.

A description is given of water movements in the soil when the irrigated surface is restricted by a 40-cm-diam hollow dug in the soil. Vertical and lateral water movements have been followed with a neutron-moisture meter designed for deep measurements. Several tubes, 1 m apart and extending to a depth of 3 m, are placed in a brown, clay–limestone soil on the site of the Cadarache Nuclear Research Center. The hollow is dug around the central tube and a constant water level maintained in it. Water profiles taken at regular intervals of time over a period of several months show the infiltration on the central tube and diffusion on the outer tubes. On the central profile, the rate of advance of the infiltration front decreases with time. After some days, equilibrium is established between the water supply and the diffusion and evapotranspiration losses, and the soil moisture tends towards a constant value. Examination of the other profiles indicates vertical and lateral water movements and gives qualitative and quantitative information on the volume of moistened soil and the moisture limit. The phenomena observed can be explained by competition between gravity and suction forces and by the fact that the central profile, which is constantly under water, is not subject to evaporation, whereas in the others evaporation causes a rising movement of moisture. These investigations form part of the studies on the radiological safety of sites, for which purpose it is important to know the water movements in the first few meters of soils likely to be contaminated by the spilling of radioactive liquids. (auth)

23148 IN-SITU DETERMINATION OF SOIL-RETENTION CAPACITY USING A NEUTRON-MOISTURE METER. Marcesse, J. (Centre d'Etudes Nucleaires, Cadarache, France). pp 137-44 of Isotope and Radiation Techniques in Soil Physics and Irrigation Studies. Vienna, International Atomic Energy Agency, 1967. (In French).

From Symposium on the Use of Isotope and Radiation Techniques in Soil Physics and Irrigation Studies, Istanbul. See STI/PUB-158; CONF-670641.

The neutron-moisture meter provides a means of making in situ measurements of soil–water reserves to ±1%, and of carrying out repeated and nondestructive measurements at a given point. These advantages are exploited in a study of the development of the water profile in homogeneous ground after irrigation. The results provide a clear interpretation of the phenomenon of drying. Analysis of water movement as a function of time at a given level demonstrates the existence of two exponential kinetic processes. One is associated with rapid run-off by gravity and the other, which is much slower, reflects the capillary forces and tends towards equilibrium which occurred at about zero. From this a value is deduced for the retention capacity, considered as the amount of soil moisture causing the slow kinetic process. This value corresponds quite well to the generally accepted definition for retention capacity, i.e., the maximum level of moisture causing only a slow infiltration or, from an agronomical point of view, the maximum volume of water which can be stored in the soil and which is available to plants. This method has the advantage of not involving a predetermined value for capillary potential and of taking the structure of the soil into account. By making similar calculations at each depth, the author constructs a profile for retention capacity, which can be used at any time to estimate a moisture deficit or the amount of irrigation required. (auth)

23149 DETERMINATION OF SOIL-MOISTURE CHARACTERISTICS FOR IRRIGATION PURPOSES BY NEUTRON-MOISTURE METER AND AIR-PURGED TENSIOMETERS. De Boodt, M.; Hartmann, R.; De Meester, P. (State Faculty of Agricultural Sciences, Ghent). pp 147-59 of Isotope and Radiation Techniques in Soil Physics and Irrigation Studies. Vienna, International Atomic Energy Agency, 1967.

From Symposium on the Use of Isotope and Radiation Techniques in Soil Physics and Irrigation Studies, Istanbul. See STI/PUB-158; CONF-670641.

Soil-moisture characteristics such as moisture content and capillary conductivity are of the greatest importance for working out a rational system to irrigate land. To realize such a system the following data must be known: (1) how much water leaves the soil profile at a given period of time; and (2) in what direction. Up to now the first point could only be assessed in a nondestructive way by using a lysimeter and assuming that the soil in it is exactly the same and behaves similarly to the soil that is to be irrigated. The second point can be solved by putting a series of tensiometers in the profile and comparing the total water potential at different depths. Here the problem is to operate the tensiometers so that the true potential is measured; this means that a special device on the tensiometer must be present to purge the water in the cup and in the manometer of air each time a reading is carried out. By combining the data of the two instruments mentioned above, the capillary conductivity can be calculated by using Darcy's law. When the moisture content, the moisture tension, the direction of the moisture gradient and the capillary conductivity are known, the infiltration rate and the depth that the waterfront will reach can be predicted when irrigating a given soil with a certain quantity of water. Hence the exact amount of water needed can be calculated to ensure also, on the one hand, that no water except the quantity needed to wash out the salts is wasted in the subsoil and, on the other hand, that enough water is given to reach the active-root zone of the plants. Valuable data on the amount of water leaving the soil can be obtained by the neutron-moisture meter, and a comparison is made between these data and the actual evaporation calculated by Penman. A detailed scheme is also presented on how to rebuild the classical tensiometers to satisfy the requirements stated above. (auth)

23150 NEUTRON-MOISTURE METER IN STUDIES OF THE EFFECT OF FALLOW ON WATER CONSERVATION IN ARID REGIONS. Ozbek, Nurinnisa; Aksoy, Tevfik; Celebi, Gurkan (University of Ankara, Turkey). pp 161-74 of Isotope and Radiation Techniques in Soil Physics and Irrigation Studies. Vienna, International Atomic Energy Agency, 1967.

From Symposium on the Use of Isotope and Radiation Techniques in Soil Physics and Irrigation Studies, Istanbul. See STI/PUB-158; CONF-670641.

For a long time it has been a common practice for the Central Anatolian farmers to leave half the land fallow the whole year in order to increase the amount of water conserved. The main object of these studies was to ascertain whether fallow has an effect on moisture conservation in soils of this region and if so what was its degree of efficiency on a yearly basis. In view of the intensity and distribution of rainfall Ankara, Konya and Eskisehir were selected for moisture-measurement areas. Altogether 60 holes were dug and 60 access tubes were used for moisture measurements by a neutron-moisture meter, and they were placed at six different locations on either state farms or a dry-farming experimental station. In each location the first group of access tubes were placed in fallow soil, the second in a wheat field and the third in a wheat field after harvest. Each treatment had three replicates. In all holes the moisture measurements were made at five different depths at intervals of either 15 days or one month. At the beginning of the moisture measurements a separate calibration curve was prepared for each location and for each treatment. The measurements were begun in 1964 and are continuing, but with some variations in the sampling technique. Some physical properties of the soils that were sampled from measurement areas, such as texture, field capacity and wilting point, were determined. Some bulk-density measurements were also made by gamma-ray transmission. The results obtained are averaged and illustrated in tables and figures. Necessary calculations and comparisons were made to show the efficiency of the fallow system in the moisture conservation in this dry soil. The results can be summarized as follows: (1) The total amount of water conserved in the soil down to a depth of 1.80 cm was higher in fallow soil than in the other two cases. This was true for all locations over a period of two years. (2) The amounts of water conserved by the effect of fallow changed, depending upon the locations and years, but differences were generally small. (3) With some exceptions, the increase in the amount of conserved water in fallow soil reached 20 to 22% of the average annual rainfall of the region. This was true for all locations over a period of two years. (auth)

23151 NEUTRON-MOISTURE GAGE IN AGRICULTURAL AND HYDROLOGICAL FIELD STUDIES IN SUB-HUMID AREAS. Dagg, M. (East African Agriculture and Forestry Research Organization, Muguga, Kenya). pp 177-87 of Isotope and Radiation Techniques in Soil Physics and Irrigation Studies. Vienna, International Atomic Energy Agency, 1967.

From Symposium on the Use of Isotope and Radiation Techniques in Soil Physics and Irrigation Studies, Istanbul. See STI/PUB-158; CONF-670641.

In areas where the annual potential evapotranspiration appreciably exceeds the annual precipitation, but where there are seasonal surpluses of rain to recharge the soil profile to a considerable depth, the natural vegetation and successful crops have deep root systems which develop large soil-moisture deficits in the dry season. The clarification of many agronomic and hydrological problems in these circumstances requires frequent field estimates of the quantitative soil-moisture status for which the neutron soil-moisture gauge is admirably suited, and surface soil-moisture difficulties are minimized. Moreover, it is self-contained and needs no external power supply, which is an important consideration in remote areas. Research workers involved in earlier studies in East Africa have had to make do with resistance units for qualitative information on soil–water status, and several illustrations of their use from catchment area experiments, root development studies and water penetration studies are given. All these types of investigation could have benefited from the quantitative neutron method with little extra efforts involved. Experience with a single soil-moisture probe with the source mounted at the end of the detector points to the importance of having a suitable geometry of source and detector to ensure a linear response curve over a very large range of soil-moisture content. (auth)

23152 KINEMATICS OF SOIL WATER. Raats, P. A. C. (Dept. of Agriculture, Madison, Wis. Univ. of Wisconsin, Madison). pp 191-200 of Isotope and Radiation Techniques in Soil Physics and Irrigation Studies. Vienna, International Atomic Energy Agency, 1967.

From Symposium on the Use of Isotope and Radiation Techniques in Soil Physics and Irrigation Studies, Istanbul. See STI/PUB-158; CONF-670641.

Relatively simple physical-mathematical models have been quite successful in describing the flow of water in saturated and in partially saturated soils. The main features in these models are, (1) a balance of mass for the water, (2) a dynamic statement relating the velocity of the water relative to the solid phase, to the forces causing the movement of the water, and (3) a capacity relation, e.g., for a partially saturated soil the relationship between the water content and the pressure head. These models treat the soil water in a macroscopic sense as a continuous medium. Kinematics deal with concepts that are useful in characterizing the motion of a continuous medium. Regarding the soil water as a continuous medium leads naturally to a discussion of the kinematics of soil water. Among the kinematic concepts considered are: velocity, vorticity, stream line, path line, streak line, and collections of particles forming a surface. The main purpose is to describe the restrictions imposed upon the kinematics of the soil–water movement by conservation of mass, the dynamic law, and the capacity relation. Several special cases are discussed. The soil may be saturated; the solid phase may be homogeneous or not homogeneous; and the flow of the water may be steady or unsteady. The nature of the velocity field of the water in the various cases is discussed. The relationship between the kinematics of the motion and surfaces of equal total potential, of equal pressure potential, and, in the case of a partially saturated soil, of equal water content, is described. Radioactive tracers are very useful in studying the kinematics of soil water. The aims and limitations of several tracer techniques will be interpreted in terms of kinematic concepts. (auth)

23153 MIGRATION OF WATER AND IONS IN UNDISTURBED SOIL COLUMNS AND ITS DESCRIPTION BY SIMULATION MODELS. Poelstra, P.; Frissel, M. J. (EURATOM–ITAL, Wageningen, Netherlands). pp 203-10 of Isotope and Radiation Techniques in Soil Physics and Irrigation Studies. Vienna, International Atomic Energy Agency, 1967.

From Symposium on the Use of Isotope and Radiation Techniques in Soil Physics and Irrigation Studies, Istanbul. See STI/PUB-158; CONF-670641.

A description is given of the technique of taking 100-cm-high and 12-cm-dia soil columns without disturbing the natural build-up of the profile, the rain installation, controlled by an automatic device, that enables fluxes from 0.05 ml cm^{-2} d^{-1} to 20 ml cm^{-2} d^{-1}, and supplies the water in drops of about 0.04 ml. In this installation 25 columns can be handled simultaneously at five different flow-rates while 10 different solutions can be used for leaching; the column scanner specifically developed for measuring the distribution pattern of the labeled compound in the column; and the results of several leaching experiments in a podsolic soil with tritiated water and solutions of strontium- and calcium-labeled $CaCl_2$ at different flow-rates and concentrations. As soil is a heterogeneous system it is not possible to describe the migration by the usual chromatographic theories such as those of

Glueckauf or Hiester and Vermeulen. The mathematical description, therefore, is done by simulation models. In these models the calculation is carried out step by step by a computer whereby the conditions are varied as necessary after each step. Several models that have been tested are described and compared with experimental results. (auth)

23154 MOVEMENT OF IONS AND COLLOIDS IN UNDISTURBED SOIL AND PARENT ROCK MATERIAL COLUMNS. Kerpen, W. (Institut fuer Landwirtschaft der KFA Juelich, Ger.); Scharpenseel, H. W. pp 213-26 of Isotope and Radiation Techniques in Soil Physics and Irrigation Studies. Vienna, International Atomic Energy Agency, 1967.

From Symposium on the Use of Isotope and Radiation Techniques in Soil Physics and Irrigation Studies, Istanbul. See STI/PUB-158; CONF-670641.

Undisturbed columns of different soils (Great Soil Groups) are subjected to percolation with repeated definite volumes of water, and the eluted rates of cations and anions are determined. The transportation of ^{14}C-labeled humic acid, $^{55}Fe^{+++}$ and ^{55}Fe-labeled montmorillonite, applied to the surface of the profile column, is checked by liquid-scintillation techniques. The results show the characteristic solubility rates and sequences of the different tested ions as well as the fractions in the individual soil types. This allows the balances of annual losses to be correlated with precipitation levels. After termination of the experiments (three to four years), the soil columns are transformed into thin-section layers which, by stripping emulsion autoradiography, reveal the localization of the labeled substances within the dispersal system of the soil skeleton and plasma. To study the sequential order and quantitative relation of ion liberation in different parent rock materials, 0.5-5-m grain size particles are continuously percolated with distilled water in columns at 60°C. The recycling system allows the dissolved and collected eluted material (ions and colloids) to be analyzed at constant intervals of 1 to 2 months. Diagenetic concretions from duripan, fragipan, pseudogley, laterite, podsol and caliche are continuously leached in Soxhlet extractors and the dissolved substances analyzed. (auth)

23155 INVESTIGATIONS INTO THE BEHAVIOR OF PRECIPITATION WATER IN SOILS BY MEANS OF ^{131}I. Benecke, P. (Univ., Gottingen, Ger.). pp 227-38 of Isotope and Radiation Techniques in Soil Physics and Irrigation Studies. Vienna, International Atomic Energy Agency, 1967.

From Symposium on the Use of Isotope and Radiation Techniques in Soil Physics and Irrigation Studies, Istanbul. See STI/PUB-158; CONF-670641.

In a drained silty soil the groundwater was filled to surface level using artificial precipitation. After this a K ^{131}I-solution was added at a defined spot between two drains. Using a scintillometer the spread of the radioisotope was recorded at varying times. The results were plotted as isorates (lines connecting points of equal activity at the same time in the soil profile). The activity maximum remained at the spot of initial activation during the investigation period (two weeks). Within a few minutes after application, however, small activities of ^{131}I were found one meter away from the point of application, in both a vertical as well as a lateral direction towards the nearest drain. The movement was mainly directly downwards and closely followed a half-logarithmic time:distance relationship. From this, the minima of the observed water-flow velocity were calculated. The influence of the physical soil properties on the spreading was represented by a proportionality constant. An interpretation of this constant is difficult because of the complexity of factors involved. In addition to these quantitative results interesting qualitative conclusions can also be drawn from studying the pattern of the isorate lines: the streamlines towards drainage penetrated the subsoil to a depth of more than 2 m; a former drain ditch showed a higher permeability than the undisturbed soil. This meant that mechanical cultivation remains effective even after decades in silty soils; and vertical water flow was hindered at the borders of layers of different texture, even where there was a higher premeability in the underlying layer. (auth)

23156 MOVEMENT OF COMPLEX COMPOUNDS THROUGH DIFFERENT SOIL TYPES. Todorovic, Z.; Filip, A. (Boris Kidric Inst. of Nuclear Sciences, Belgrade). pp 241-9 of Isotope and Radiation Techniques in Soil Physics and Irrigation Studies. Vienna, International Atomic Energy Agency, 1967.

From Symposium on the Use of Isotope and Radiation Techniques in Soil Physics and Irrigation Studies, Istanbul. See STI/PUB-158; CONF-670641.

Results of the behavior of complex compounds of zinc (bivalent), iron (trivalent), cobalt (trivalent) and chromium (trivalent) on passing through four sorts of soils are given. The soils had a dominant content of sand, clay, humus and carbonate. The investigations were carried out by the radioactive tracer technique. The complexing was carried out with Na-citrate, EDTA, Na-thiocyanate, potassium cyanide, ammonium-hydroxide, Na-oxalate, Na-tartrate and Na-citrate. The effect of the excess complexing agent on the percentage of the complex compound in the eluate, retention and spread of the elution curve, is shown. The investiations were carried out on a column always filled with the same quantity of soil of given granulation. The movement of the complex compound was observed by taking samples of the eluate and measuring their activity. For each elution curve parameters $\overline{X} \pm \sigma$ were determined as a measure for the retardation and spread of the complex compound waves. The smaller the difference between retardation ($\overline{X}$) and free volume (X_0) and the smaller the standard deviation, the smaller was the retardation of the complex compound. From these characteristics and from those of the elution curves for ^{131}I and ^{35}S, which are considered to be passing through the soil without considerable difficulty, those complex compounds which showed the least retardation and wave spread on passage through the soil type investigated were determined. (auth)

23157 INFLUENCE OF IRRIGATION RATE AND SOIL TYPE ON THE VERTICAL MIGRATION OF IRON AND MANGANESE IN THE SOILS OF SOUTHEAST SPAIN. Costa, F.; Esparraguera, I.; Ortin, N.; del Val, M.; de la Cruz, F.; Carpena, O.; Cellini, R. F. (Junta de Energia Nuclear, Madrid). pp 251-68 of Isotope and Radiation Techniques in Soil Physics and Irrigation Studies. Vienna, International Atomic Energy Agency, 1967. (In Spanish).

From Symposium on the Use of Isotope and Radiation Techniques in Soil Physics and Irrigation Studies, Istanbul. See STI/PUB-158; CONF-670641.

The citrus plantations in southeast Spain, situated largely on calcareous soils which are submitted to intensive cultivation, are investigating nutritional changes caused mainly by deficiencies of trace elements, especially iron and manganese, which result in a lower yield and premature exhaustion of the trees. A radioactive tracer study was made of the behavior of these ions in soils and the factors influencing their migration to the root zone; the object of the work is to develop a rational and economic fertilization policy. The work has been based on two types of soil, representing extreme situations encountered in practice: one soil is calcareous and the other non-calcareous. A set of columns was assembled, each column having a length of 1 m and a cross-section of 32 cm^2; solutions of ^{59}Fe and ^{54}Mn were added to these columns both in sulphate and chelate form. A definite amount of water, proportional to the requirements of citrus plantations, was intermittently passed through these columns. Soil samples were taken periodically and the total activity and the activity of the assimilable and non-assimilable fractions of the elements being studied were measured. At the same time an apparatus involving a collimated scintillation detector was developed to follow the vertical migration of these ions in soils; the water drained from the columns after each irrigation was analyzed radiochemically for the same purpose. (auth)

23158 DETERMINATION BY INDICATOR ACTIVATION ANALYSIS OF THE SORPTION CONDITIONS, THE MOVEMENT, AND THE DE-ENRICHMENT FACTOR OF ANIONS AT A SITE ON THE DANUBE. Kuehn, W. K. G. (Technische Hochschule, Hanover). pp 271-8 of Isotope and Radiation Techniques in Soil Physics and Irrigation Studies. Vienna, International Atomic Energy Agency, 1967.

From Symposium on the Use of Isotope and Radiation Techniques in Soil Physics and Irrigation Studies, Istanbul. See STI/PUB-158; CONF-670641.

To determine the sorption conditions of anions and their movement in the ground, ^{127}I available as KI in an aqueous solution was evenly distributed over a site of 10 × 10 m on the Danube. The iodide was determined by indicator activation analysis using neutron activation. Soil samples were taken from inside and outside the distribution area by Puerkhauer drills to a depth of 2.50 m at 50-cm distances after 5, 10, 24, 72, and 1000 hr. After being processed the samples were activated in a reactor. The results show that anionic iodide especially is present directly below the distribution area at a depth down to 2.5 m. Two meters from the edge of the distribution area the concentration was only double the amount of naturally present iodide, while at a distance of 4 m and over, the iodide concentration of more than 70 soil samples was within the iodide background (0.3 ppM). The migration rate is rather high at first and slows down with time. After five hours a depth-migration rate of about 40 cm/hr was found, which earlier must have been considerably higher (about 2-3 m/hr). From the iodide concentration at a 2-m depth and at the surface, a de-enrichment factor of 4.5×10^4 was found. The degree of de-enrichment obviously depends on the soil structure. The method developed can

be used in individual cases to determine the concentration of anions that penetrate the soil at much higher rates than cations. The method can be applied to other anions to determine their movement and concentration in the soil as a function of interrelationships of depth, soil structure and irrigation. (auth)

23159 STUDIES ON TAGGED CLAY MIGRATION DUE TO WATER MOVEMENT. Scharpenseel, H. W. (Univ., Bonn); Kerpen, W. pp 279-87 of Isotope and Radiation Techniques in Soil Physics and Irrigation Studies. Vienna, International Atomic Energy Agency, 1967.

From Symposium on the Use of Isotope and Radiation Techniques in Soil Physics and Irrigation Studies, Istanbul. See STI/PUB-158; CONF-670641.

^{55}Fe-tagged clay minerals, produced by hydrothermal synthesis, serve to clarify the question whether clay migration or clay formation in situ is the predominating mechanism in the B_t-development of Parabraunerde (sol brun lessivé, grey brown podsolic, hapludalf, dernopodsol). They further indicate the possibilities of clay transportation caused by water percolation. Suitable experimental approaches, such as thin-layer chromatography and autoradiography, translocation tests in columns filled with monotypical textural fractions or with undisturbed soil profiles, and synchronous hydrothermal treatment of ^{55}Fe-containing material from different horizons of Parabraunerde, to reveal the specific readiness of the different profile zones for ^{55}Fe-clay production, are described. The possibilities of clay percolation are discussed. (auth)

23160 USE OF TRITIATED WATER TO STUDY WATER CIRCULATED IN A SANDY SOIL IN SENEGAL. Charreau, C.; Jacquinot, L. (Centre de Recherches Agronomiques, Bambey, Senegal). pp 301-14 of Isotope and Radiation Techniques in Soil Physics and Irrigation Studies. Vienna, International Atomic Energy Agency, 1967. (In French).

From Symposium on the Use of Isotope and Radiation Techniques in Soil Physics and Irrigation Studies, Istanbul. See STI/PUB-158; CONF-670641.

A study was carried out in Senegal on the behavior, with respect to the soil solution, of a flow of water infiltrating a sandy soil under a constant head. The experimental set-up consisted of a cylindrical lysimeter 2 m high and 1 m in diameter. The initial water content of the soil was increased to near field capacity. A sheet of tritiated water 3 cm deep was then maintained on the soil surface. The drainage water was collected in 5-liter amounts and the radioactivity measured in the laboratory. First the infiltration and drainage rates for dry and wet soil are compared. From examination of the curve showing variations in the concentration of tritiated water in the drainage water as a function of the amount of drainage water it can be seen that the tritiated water begins to appear in the drainage water before the water initially in the soil has been completely replaced. The concentration then increases rapidly and approaches the original value. From the shape of the curve it is concluded that the soil solution is not immediately displaced in its entirety by the applied water, even in very sandy soil; instead, there is an intermediate phase during which the two solutions present are progressively mixed. This phase involves a total of 102 mm of water, of which 42 mm is tritiated water. The mixing occurs within an 80-cm thick soil layer. Possible agronomic consequences of the processes studied are discussed. (auth)

23161 RADIOACTIVE TRACERS IN THE STUDY OF CONTEMPORARY PROBLEMS IN THE PHYSICAL HYDROLOGY OF SOILS. Bondarenko, N. F.; Globus, A. M. (Agrophysical Inst., Leningrad). pp 291-9 of Isotope and Radiation Techniques in Soil Physics and Irrigation Studies. Vienna, International Atomic Energy Agency, 1967. (In Russian).

From Symposium on the Use of Isotope and Radiation Techniques in Soil Physics and Irrigation Studies, Istanbul. See STI/PUB-158; CONF-670641.

The principle of the isothermal movement of soil moisture departs appreciably from Darcy's law in a number of cases of practical importance. The probable reasons for this digression are reviewed. In non-isothermal transfer of moisture it is vital to determine the phase composition of the flow. Use of radioactive labeling can throw light on these questions, which are of prime importance in elaborating the physical bases of soil-moisture theory and in developing techniques for predicting and regulating soil–water cycles. (auth)

23162 TRITIUM TAGGING OF SOIL MOISTURE: THE WATER BALANCE OF FOREST SOILS. Blume, H. P.; Zimmermann, U.; Muennich, K. O. (Univ., Heidelberg). pp 315-31 of Isotope and Radiation Techniques in Soil Physics and Irrigation Studies. Vienna, International Atomic Energy Agency, 1967.

From Symposium on the Use of Isotope and Radiation Techniques in Soil Physics and Irrigation Studies, Istanbul. See STI/PUB-158; CONF-670641.

A method of tagging soil moisture with tritium in order to measure water movement and groundwater recharge, and the results obtained by this method were reported previously. The amount of tritium to be applied is evaluated. A new technique of labeling was tested. The soil was inoculated with tritiated water with a syringe to a depth of approximately 20 cm. This technique prevents the following effects occurring if the tracer remains for a longer time in the immediate neighborhood of the soil surface such as high evaporation loss of the tracer, asymmetry of the tracer-concentration distribution, and heavy rains overtaking the tracer peak if there are cracks in the upper soil layers. The spatial distribution, both vertically and horizontally, of the tritium thus injected into a sandy soil was measured after artificial sprinkling. The influence of varying water content in the soil on the tracer-concentration distribution and the influence of a clay pan on the water movement were investigated. Also presented are results obtained in a forest soil tracer study at present being conducted over a two-year period. Two individual labelings at the same place, but six months apart, demonstrate the uptake of water by the roots between the two tracer marks. (auth)

Meteorology

Refer also to abstracts 23133, 23314, 23910, and 25231.

23163 (A/AC.82/G/L-1192) RADIOAKTIVNOST ATMOSFERNOGO VOZDUKHA I NEKOTORYKH PRODUKTOV PITANIYA V G. MOSKVE V 1965 I 1966 GG. (Radioactivity of the Atmospheric Air and of Some Food Products in Moscow in 1965 and 1966). Zykova, A. S.; Telushkina, E. L.; Evremova, G. P.; Kuznetsova, G. A.; Rublevskii, V. P.; Shumakov, V. I. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow). 1967. 12p. (In Russian). Dep.

The radioactivity of the air and of the fallout deposited on milk, potatoes and vegetables in the Moscow district was measured. The β active materials content was determined by means of a counter with a 2 mg/cm^2 thick mica window; the isotopic composition was obtained from monthly radiochemical determination of the ^{90}Sr and ^{137}Cs content and γ-spectrometric analysis of ^{95}Zr–^{95}Nb, ^{144}Ce–^{144}Pr, ^{141}Ce, ^{103}Ru, ^{106}Ru–^{106}Rh and of some other γ emitters. The results indicated that the radioactivity level of the air in Moscow continues to decrease. The fallout contains primarily ^{106}Ru–^{106}Rh, and ^{144}Ce–^{144}Pr. The absolute value of ^{137}Cs and ^{90}Sr, expressed in absolute units of μCi/km^2, continued to decrease but the relative contribution of these radioisotopes to the total β activity increased. The ^{137}Cs/^{90}Sr ratio changes indicated that the ^{137}Cs-bearing aerosols are removed at a faster rate from the troposphere than those containing ^{90}Sr. The concentration of these two isotopes in the milk did not decrease noticeably during 1965 and 1966, pointing to a strong contamination of the soil by them and the strong effect of this contamination on the milk. (TTT)

23164 (NP-17330) MEASUREMENTS OF FISSION PRODUCT ACTIVITY IN AIR AND IN PRECIPITATION UP TO 30 JUNE 1967. Report No. 27. (Forsvarets Forskningsrad, Copenhagen (Denmark)). Oct. 20, 1967. 8p. Dep.

Air and precipitation samples collected in Denmark, the Faroes and Greenland were measured for total-β-activity, ^{137}Cs and in some cases ^{90}Sr and ^{140}La. Air samples collected in Thule in the last three weeks of January 1967 contained remarkably large amounts of ^{95}Zr. (auth)

23165 (PROT.-SAN.-12/67) DATA ON ENVIRONMENTAL RADIOACTIVITY COLLECTED IN ITALY, JULY–DECEMBER 1966. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). Apr. 1967. 196p. Dep.

The results of radioactivity monitoring measurements made at numerous stations throughout Italy during July through December 1966 are tabulated. The radioactivity of ^{137}Cs and ^{90}Sr in air, foods, milk, soil, and surface waters is emphasized. (L.L.C.)

23166 EFFECT OF FOG ON THE ^{222}Rn CONTENT IN THE LOWER LAYERS OF THE TROPOSPHERE. Cieplinski, Jan; Pawlak, Marian (Center for Radiological Defense and Radiobiology, Warsaw). Acta Geophys. Pol., 15: 139-45(1967). (In Polish).

During a prolonged period of fog over Warsaw continuous observations were made of the ^{222}Rn concentration in the near-ground layers of the atmosphere in an attempt to determine the effect of fog on concentrations of this element. The ^{222}Rn content

was one order of magnitude higher than during sunny and/or rainy days. The possible effect of certain other meteorological factors, such as pressure and temperature, on the ^{222}Rn content in the air during periods of fog was studied. A relation was found to exist between variations in the ^{222}Rn concentration in the lower layers of the troposphere and the derivative of the pressure; ^{222}Rn content increases with a negative derivative value and decreases with a positive value. The results failed to substantiate any unambiguous relation between the content of ^{222}Rn in the air and the ambiental temperature. (ATD)

23167 SEASONAL VARIATION OF ^{90}Sr FALLOUT AT NIIGATA. Kanda, Yukio; Sotobayashi, Takeshi (Niigata Univ., Japan). Nippon Kagaku Zasshi, 89: 206-8(Feb. 1968). (In Japanese).

The deposition rate of ^{90}Sr is at a maximum value in spring and a minimum in autumn. Long-term measurements, however, revealed some details in the seasonal variation. In the past eight years, both the values of the monthly deposition per unit area (mCi/km^2) and the monthly specific activity ($pCi/m^2/mm$) for ^{90}Sr reach the minimum in August. The maximum deposition rate was found from January to March and the maximum specific activity, from March to May. This result may be caused by a characteristic feature of the local weather conditions. The ratios of maximum to minimum value for the monthly deposition and the monthly specific activity were evaluated for 1959 ~ 1966. Two unusual values of 27 and 4 were observed in 1959 and 1961, 1 year after the ends of 1957 ~ 1958 and the 1961 ~ 1962 test series, respectively. This would be due mainly to the differences in the total explosive powers and the altitudes of the explosion between the two test series. (NSA of Japan)

23168 CHEMICAL COMPOSITION OF DEW AND DRY FALLOUT IN JERUSALEM, ISRAEL. Yaalon, D. H.; Ganor, E. (Hebrew Univ., Jerusalem). Nature (London), 217: 1139-40 (Mar. 23, 1968).

Results of an analysis of dew collected during the dry summer season of 1967 are presented, and the data are compared with analyses of precipitation and dry fallout carried out during previous years. It was concluded that moisture that condenses as dew scavenges salts and aerosols from the air in the same way as bulk precipitation. (U.K.)

23169 CONCENTRATIONS OF ^{137}Cs IN RAINWATER AND MILK IN AUSTRALIA DURING 1966. Bonnyman, J.; Duggleby, J. C.; Molina-Ramos, J.; Paterson, I. C. (Commonwealth X-Ray and Radium Lab., Melbourne). Aust. J. Sci., 30: 313-17(Feb. 1968).

During 1966, monthly measurements were made of the ^{137}Cs content in rainwater and milk at six monitoring stations in Australia. The results are tabulated and show that the annual deposition of ^{137}Cs in the Australian environment was lower than in the preceding two years and that the ^{137}Cs content in milk was down 40% from 1965 and at its lowest level in four years. (L.C.L.)

23170 ^{90}Sr IN THE AUSTRALIAN ENVIRONMENT DURING 1966. Fletcher, W. (United Kingdom Atomic Energy Authority, Capenhurst, Eng.); Gibbs, W. J.; Moroney, J. R.; Stevens, D. J.; Titterton, T. W. Aust. J. Sci., 30: 307-13(Feb. 1968).

During 1966 measurements were made of the ^{90}Sr content in precipitation, soils, liquid milk, flour, and human bone tissue at eight monitoring stations throughout Australia. From these measurements, the mean deposition of ^{90}Sr was determined to be about 1 $mCi/km^2/yr$. The results are tabulated and compared with data from preceding years. (L.C.L.)

23171 FALLOUT BY THE PRECIPITATION OF FISSION PRODUCTS FROM THE SUBCLOUD LEVEL OF THE ATMOSPHERE. Burtsev, I. I.; Malakhov, S. G. (Inst. of Applied Geophysics, Moscow. Inst. of High-Altitude Geophysics, Moscow). Izv. Akad. Nauk SSSR, Fiz. Atmos. Okeana, 4: 328-34 (Mar. 1968). (In Russian).

The self-cleaning of the lower troposphere from radioactive aerosols is studied for the period of nuclear tests. Measurements were carried out on the high-altitude stations of the Caucasus. It was shown that the convective clouds clean the radioactive contaminants from the atmosphere better than the strati clouds. The subcloud level is cleaned to a considerable extent by the precipitations of small intensity. The washout coefficient of the fallout products with the age of 4 to 5 months was 5.9×10^{-5} sec^{-1} for snow and 3.1×10^{-5} sec^{-1} for rain. (auth)

23172 COLLECTION OF RADIO-IODINE IN RESPIRATORY FILTERS. Jacobi, W.; Hacke, J. Staub, 26: 436-40(Oct. 1966). (In German).

The collection of radio-iodine in respirator filters and their two components (fiber and activated charcoal filters) was studied by the multiple filter method. By this means, the various iodine components in the air were separated and their fractions determined. Elemental iodine and iodine attached to aerosols are retained very efficiently by the filter, through which a third, weak iodine component (probably methyl iodide) passes rather easily. The fraction of this component in the air decreases in inverse proportion to the iodine concentration in air and was about 0.03% for a specific ^{132}iodine activity of about 10^{-4} Ci/m^3. The corresponding iodine penetrability of the filter was 0.02%. (auth)

Mineralogy and Exploration

23173 (67-CNA-410) REVIEW OF NUCLEAR FUEL REQUIREMENTS AND RESOURCES. Faulkner, R. L. (Division of Raw Materials (AEC), Washington, D. C.). [1967]. 7p. (CONF-670522-12). Dep.

From International Conference on World Review of Nuclear Reactors and Radioisotopes, Montreal, Canada.

Estimates of known uranium ore reserves and the scale of exploration needed to meet fuel requirements for reactors up to 1990 are discussed. (F.S.A.)

23174 (NP-17371) URANIUM RESOURCES. Revised Estimates. (European Nuclear Energy Agency, Paris (France). International Atomic Energy Agency, Vienna (Austria)). Dec. 1967. 26p. Dep.

The reliability of the revised estimates of uranium reserves is discussed. Uranium from the sea is considered. Uranium resource estimates are given for Argentina, Australia, Canada, Congo, Denmark, France, Gabon, India, Italy, Japan, Morocco, New Zealand, Niger, Pakistan, Portugal, South Africa, Spain, Sweden, and United States. Thorium resources estimates are also discussed. (M.C.G.)

23175 NUCLEAR FUEL CYCLE. Nucl. News, 11: 30-5(Jan. 1968).

It is predicted that demands for U for nuclear power plants in 1980 in the USA will be three times as great as the present U production facilities. Brief descriptions are given of U resources, the cost of U processing, enrichment facilities and costs, reactor fuel fabrication methods and costs, the reprocessing of reactor fuels, and the use of Pu and Th as reactor fuels. (L.C.L.)

23176 GEOLOGY AND URANIUM DEPOSITS OF THE JACKPILE MINE AREA, LAGUNA, NEW MEXICO. Nash, John Thomas. New York, Columbia Univ., 1967. 217p.

Thesis.

Major deposits of uranium occur in a sandstone tongue in the Morrison Formation, the Jackpile Sandstone, near Laguna, New Mexico. The Jackpile Sandstone occupies a northeasterly depression in the Morrison Brushy Basin Member in a braided, bifurcating stream channel. The Jackpile sandstones range from mature orthoquartzite to immature arkose, with immature subarkose being most common. Volcanic, plutonic, and sedimentary sources contributed about equally to the sandstone, but the labile constituents commonly were destroyed during or shortly after deposition. The high matrix clay content of most Jackpile sandstones inhibited cementation and made such strata less permeable to ore solutions. The Jackpile Sandstone was altered by weathering prior to Dakota deposition, at the time of Tertiary igneous intrusions, and following Tertiary igneous activity. Recognition of alteration effects caused by ore solutions is obscured by the abundant terrigenous clay matrix. Field and laboratory observations indicate that the organic environment is a critical feature of ore deposition. The structureless organic matter which precipitated most ore was mobile, and may be related to humic compounds. Gases also appear to have been important precipitants. Uranium was transported as dilute, non-reactive uranyl carbonate complexes. Upon entering an alkaline reducing environment the complex was broken and an organic-uranium-silica colloid formed, which subsequently crystallized to coffinite. The formation of chlorite from montmorillonite, and the extensive solution of silicates are a record of conditions in the organic-ore environment: coffinite forms with a pH greater than about 7.5 and activity of silica about $10^{-2.7}$. The discovery of ore truncated by the pre-Dakota unconformity indicates that ore was emplaced before the Jackpile was buried. A single age for the coffinite is about 94 MY, relative to a late Cretaceous age for the Dakota. There appear to be only two possible sources of ore prior to the Dakota: post-volcanic emanations or labile constituents in the Jackpile Sandstone. The preservation of delicate volcanic detritus and euhedral quartz crystals indicate that volcanism occurred through Morrison time and was near the Jackpile channel, although no facies changes or alteration halos indicate the location of the vent. Sandstone pipe structures, such as the Woodrow

pipe, may have been formed by deep seated activity and served as conduits for thermal emanations. Petrographic studies indicate that about 20% of the original volume of the Jackpile Sandstone was destroyed during and shortly after deposition. Trace amounts of uranium present in such a large quantity of material may have been concentrated to form the deposits. (Disser. Abstr.)

23177 MINERALOGIC CONSTITUTION, PROPERTIES, AND GENESIS PROBLEMS OF THE URANIFEROUS ORE DEPOSIT OF THE MECSEK MOUNTAIN. I. Kiss, J. (Univ. L. Eotvos, Budapest). Ann. Univ. Sci. Budapest. Rolando Eotvos Nominatae, Sect. Geol., 9: 139-88(1966). (In French).

The mineralogic constitution of the Mecsek Mountain is described. The alotagenic and the secondary minerals constituting the ore deposit can be divided into three groups: U minerals, sulfides and sulfosalts, and nonuraniferous salts. The nonmetallic ores found are described in some detail. The sulfides and sulfosalts accompanying U are discussed. The minerals found and their composition are reported. (J.S.R.)

Oceanography

23178 (A/AC.82/G/L-1177) REZUL'TATY OPREDELENIYA STRONTSIYA-90 V VODAKH INDIISKOGO OKEANA V 1962 G. (Results of the Determination of ^{90}Sr in the Waters of the Indian Ocean in 1962). Popov, N. I.; Orlov, V. M. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow). 1967. 8p. (In Russian). Dep.

The concentration and distribution characteristics of ^{90}Sr in the waters of the northeast range of the Indian Ocean in the summer of 1962 are analogous, in general outlines, to that observed in 1960-1961 in the central and northern areas of the ocean. It was found that reagents, used for the determination of ^{90}Sr, can have an appreciable background activity. Running dummy analyses appear to be an essential condition for the accurate evaluation of the ^{90}Sr content in samples of ocean water. (tr-auth)

23179 (A/AC.82/G/L-1191) ISSLEDOVANIE RASPROSTRANENIYA RADIOAKTIVNOGO ZAGRYAZNENIYA, OBUSLOVLIVAEMOGO SBROSOM RADIOAKTIVNYKH OTKHODOV V IRLANDSKOE MORE. (Investigation into the Dissemination of Radioactive Contamination as a Result of the Discharge of Radioactive Waste into the Irish Sea). Kolesnikov, A. G.; Nelepo, B. A. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow). 1967. 14p. (In Russian). Dep.

An analysis of the results obtained makes it possible to determine the basic characteristics of the transfer processes of radioactive contamination in the northeastern part of the Atlantic Ocean. The northeastern part of the Atlantic Ocean is intensively contaminated as a result of the discharge of radioactive wastes in the Irish Sea. The transfer of radioactive contamination in the northeastern Atlantic is explained by the North Atlantic current and is done in all moving layers of the ocean. At a distance of 600 miles from the site of waste discharge, the radioactivity of the surface water of the Norwegian Sea is three times higher than the activity caused by the total precipitation on the ocean surface. The intense intermixing of the water in the Thomson threshold area appears as the reason for the rapid contamination of the deep water of the northeastern Atlantic. The characteristics of the distribution parameters of the radioactivity field are determined by the flow velocity and are related to the structure of the water mass of the area investigated. (tr-auth)

23180 (NYO-3648-5) GEOCHEMISTRY OF ORGANIC AGGREGATE FORMATION IN THE OPEN OCEAN. Final Report. Wangersky, Peter J. (Dalhousie Univ., Halifax (Nova Scotia). Inst. of Oceanography). Feb. 1968. Contract AT(30-1)-3648. 12p. Dep. CFSTI.

The cycle of organic carbon in seawater and its relation to the cycle of inorganic carbon are being investigated. Analytical procedures are being developed for monitoring the content of dissolved, suspended, and air-borne carbon in the marine environment. (M.C.G.)

23181 (UCSD-34-P-74-1) RADIOCARBON MEASUREMENTS IN THE SUBSURFACE AND DEEP WATERS OF THE PACIFIC OCEAN. Final Report. (California Univ., La Jolla, San Diego). Mar. 13, 1968. Contract AT(11-1)-34. 43p. Dep. CFSTI.

A program for measuring the ^{14}C content in deep waters (3000 m or more) of the Pacific Ocean was undertaken to determine the age of the deep water and to use this age as an indication of the overall time necessary for the water to move from one spot to another. During the International Geophysical Year, deep samples were obtained from approximately 40°S and 15°N in the Pacific. Subsequently, similar samples were obtained in the Indian Ocean and North Pacific. The sampling equipment and methods are described, and the measured data are tabulated. The results show that in the Pacific Ocean, the ^{14}C content decreases constantly from south to north well into the northern hemisphere. In the Indian Ocean, the situation is similar but less distinct. The difference in apparent "age" of the deep Pacific water from 40°S to 15°N is about 300 to 400 years, corresponding to an overall average velocity of 0.4 to 0.5 mm/sec. The corresponding velocities in the southern part of the Indian Ocean are about 0.2 to 0.3 mm/sec. Although this study was primarily concerned with deep water, it became apparent that surface water ^{14}C measurements were equally important for studying the interactions between the troposphere and surface ocean water. Data on the surface measurements are included in the tabulations. (L.C.L.)

23182 DETERMINATION OF OCEANIC SEDIMENTATION RATE BY A NONDESTRUCTIVE GAMMA SPECTROMETRIC METHOD. Yokoyama, Yuji; Tobailem, Jacques; Grjebine, Tovy; Labeyrie, Jacques (CEN de Saclay, Gif-sur-Yvette, France). Geochim. Cosmochim. Acta, 32: 347-52(Mar. 1968). (In French).

The method employed consists of following the decay of the ratio Io: Th as a function of depth in the core of sediment by measuring the gamma-rays emitted from their descendents. The sedimentation rate of an Indian Ocean core was determined as 1.2 mm/1000 yr. This value is compatible with previous results obtained by the chemical separation of thorium isotopes. (auth)

Seismology

23183 MEASUREMENT OF $dT/d\Delta$. Douglas, A.; Corbishley, D. J. (United Kingdom Atomic Energy Authority, Reading, Eng.). Nature (London), 217: 1243-4(Mar. 30, 1968).

A method is described for estimating directly the derivative of the travel time curve of seismic body waves, $dT/d\Delta$, as a function of epicentral distance Δ, by combining data from several seismometer arrays. In order to test the method the $dT/d\Delta$ curve for P waves for the range 67 to 89° was estimated. The results provided further evidence for rather rapid changes in the velocity gradient in the Earth's deep mantle. Inversion of the $dT/d\Delta$ curve to produce a velocity depth structure for the Earth is the ultimate aim of the work. (UK)

23184 STUDY ON EARTHQUAKE RESISTING STRENGTH OF NUCLEAR REACTOR CONTAINMENT VESSELS. Arita, Yuko; Satake, Masaru (Mitsubishi Heavy Industries, Ltd., Tokyo). Mitsubishi Juko Giho, 5: 11-17(Jan. 1968). (In Japanese).

In the seismic design of nuclear reactor containment vessels, it is usual that their vibration as a shell is neglected. This assumption, however, is not yet justified. Tests were conducted using an elastically similar model made of celluloid to investigate this phenomenon, and as a result it was found that vibration as a shell could not be neglected. Local stress tests were also carried out, using a larger similar model made of steel, and the method of reinforcement was investigated. Finally, artificial earthquake tests were conducted by the use of dynamite to verify the above test results. (NSA of Japan)

ENGINEERING

Nuclear Explosions

23185 (HNS-1229-43) GROUND-WATER MONITORING. Davis, Stanley N.; Lynch, Edward J. (Bradberry (Carroll E.) and Associates, Inc., Los Altos, Calif.). Dec. 18, 1963. Contract AT(29-2)-1229. 77p. Dep. CFSTI.

For Hazleton-Nuclear Science Corp., Palo Alto, Calif.

The underground detonation of a nuclear device introduces into the ground a potential source of contamination of nearby groundwater systems. This report presents a study of this problem from the aspect of detection and surveillance of such contamination. Monitoring of ground water for radionuclides is best accomplished by means of wells placed as close as possible to the source of contamination or to the predicted path of contaminant travel. Uncertainties in the spatial variations of porosity and permeability, along with inaccuracies in measuring hydraulic heads in some aquifers, make it difficult to predict the exact direction of movement of the contaminated water. Consequently, sufficient pumping of the wells is necessary to insure that water from a large area is intercepted. Analytical expressions and nomograms have been developed to assist in estimating the necessary pumping rates, and the travel time and dilution of the contaminants en route to the monitor well. This information, combined with a detailed hydrologic study of an area of interest, will make possible the planning of an effective monitoring system. For greatest economy, the monitoring program should be planned in conjunction with other activities related to the preparation for a detonation. (auth)

23186 (ORNL-TM-2198) CHEMICAL APPLICATIONS OF NUCLEAR EXPLOSIONS (CANE). Progress Report, January 1–March 31, 1968. Arnold, W. D.; Blake, C. A. Jr.; Crouse, D. J. (comps.) (Oak Ridge National Lab., Tenn.). Apr. 10, 1968. Contract W-7405-eng-26. 13p. Dep. CFSTI.

A new sample of underground test shot rubble was received for use in blending with copper ore to simulate nuclear broken ore. The gross gamma activity of the rubble was about 10^4 counts $min^{-1}g^{-1}$, attributable mainly to ^{106}Ru, ^{125}Sb, and ^{137}Cs. Tritium contamination of Green River oil shale and of the oil retorted from the shale increased with time of exposure of the shale to water vapor containing tritiated water in a sealed flask at 85°C. The amount of contamination was lower when the tritiated water, constant in quantity, was diluted with additional light water. The thermal stability of americium oxide preparations has been examined up to 1600°C in air, oxygen, and in vacuum. The final products were confirmed by x-ray analysis to be AmO_2. The dioxide decomposed slightly above 1400°C. Weight changes below 600°C are tentatively ascribed to decomposition of nitrate and carbonate contaminants. (auth)

23187 (UCRL-50385) RESULTS OF AN EXPLORATION INTO THE TOP OF THE PILEDRIVER CHIMNEY. Boardman, C. R. (California Univ., Livermore. Lawrence Radiation Lab.). Oct, 1967. 27p. Dep. CFSTI.

A vertical exploratory hole, U15.01 PS #1V, was drilled into the top of the chimney formed by the Piledriver Event—a 61-kt underground nuclear shot in granitic rock. Measurements of permeability made as the hole progressed indicate that the maximum vertical extent of increased permeability above the shot point may have been as high as 314.6 ± 11 meters or 7.1 ± 0.2 cavity radii. Chimney height was established at 272.2 meters or 6.2 cavity radii. Void volume in the chimney was determined by the pressurization technique to be 367,900 ± 6% cubic meters. This volume is equivalent to a sphere with a radius of 44.5 meters. These results are compared with those obtained from two other U. S. nuclear explosions in granitic rock, Hardhat and Shoal. Radii of sphered chimney void volumes scale directly with the cube root of the yield with an error of only 1%, whereas scaling based on the assumption of adiabatic cavity expansion to overburden pressure results in an error of 6%. Chimney heights scale directly with cavity radius within 20%. (auth)

23188 LOW-YIELD NUCLEAR WEAPONS. Klose, K. Militartechnik, No. 7, 301-3(1967). (In German).

The principles of low-yield nuclear weapons, the economic factors involved in the production and use of low-yield nuclear weapons, and the deployment and military utilization of low-yield nuclear weapons are reviewed on the basis of references in the literature. The properties of some U.S.-developed low-yield nuclear warheads and delivery devices are described and discussed. It is concluded that these weapons can be very easily deployed and readily fired; however, they have only a limited range and therefore pose some safety problems. They are mainly suitable for tactical applications. Their firepower is above that of any conventional artillery missile. (JPRS)

Facilities and Equipment

Refer also to abstracts 23208–23210, 23224, 23531, 23635, 23758, 24198, 24206, 25085, 25207, 25213, 25220, 25223, and 25224.

23189 (BNWL-705) LIQUID METAL MEASURING AND LOADING STATION. Yount, J. A.; Chulos, L. E. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Mar. 1968. Contract AT(45-1)-1830. 14p. Dep. CFSTI.

An economical device for the accurate measurement and dispensing of small volumes (30 to 500 ml) of liquid metal is described. Preliminary oxygen analysis shows the system contamination to be less than 33 ppM with a 20 ppM oxygen supply. This level of contamination is expected to diminish with operation. (auth)

23190 (CONF-660524–, pp 299-319) AN UNSHIELDED PILOT PLANT FOR RECYCLING ^{233}U. Schileo, G. (Babcock and Wilcox Co., Lynchburg, Va. Research and Development Div.).

A pilot plant to convert recycle fuel and fabricate prototype fuel elements of the power-reactor type is described. Initial operation with thoria–urania containing ^{233}U has been successfully demonstrated. Recycled ^{233}U is usually contaminated with a small amount of ^{232}U which, through some of its decay daughters, contributes significantly to the gamma radioactivity of recycled ^{233}U fuels, particularly in the penetrating high-energy region. A method has been developed whereby the ^{233}U fuel can be deactivated and then refabricated directly. The fuel is deactivated by removing the first daughter of ^{232}U (^{228}Th) and is then refabricated rapidly before the increase in the ^{232}U daughters and the associated gamma activity creates a hazard. Customary glove-box techniques, which are relatively inexpensive, are used in refabrication. The pilot plant was successfully tested with about 390 kg of natural material before being operated with 82 kg of oxide containing approximately 2.3 kg of ^{233}U contaminated with about 42 ppM ^{232}U. A prototype element typical of those used in pressurized-water reactors has been fabricated. Radiation exposures to the operators were well within permissible limits. The information gained during the hot runs indicates that 1000 ppM ^{232}U–^{233}U (or approximately 300 mg ^{232}U per batch) is representative of the level of impurity that can be tolerated in the existing pilot plant operating for 5 days at a capacity of 50 kg of ThO_2–3 wt % UO_2 per week. (D.L.C.)

23191 (CONF-660524–, pp 509-35) THORIUM FUEL SEPARATION ENGINEERING STUDIES. Moncrief, E. C.; Burkart, C. A.; Nitti, D. A. (Babcock and Wilcox Co., Lynchburg, Va. Research and Development Div.).

Three engineering studies on thorium-based fuel separation are discussed. The first describes a production-size ^{233}U cleanup system, and the second evaluates the capital cost for a commercial-scale reprocessing station. Both of these separation facilities are needed in a direct-fabrication concept. The final study evaluates the feasibility of separating fuel mixtures of Th–U and Th–Pu–U in a single-cycle extraction cascade. (auth)

23192 (IN-1131, pp 30-6) STATUS AND UTILIZATION OF IRRADIATION FACILITIES. (Idaho Nuclear Corp., Idaho Falls).

A description, operational parameters, and uses are given for the MTR L-51 and the PAED-59 G-12 irradiation facilities. A one-dimensional neutron diffusion code, FOG, was applied to test the feasibility of the G-12 facility for fast-fuel testing. (J.C.W.)

23193 (LA-3834) TOTAL HEMISPHERICAL EMISSIVITY MEASUREMENTS BY THE HEAT PIPE METHOD. Deverall, J. E. (Los Alamos Scientific Lab., N. Mex.). Nov. 10, 1967. Contract W-7405-eng-36. 10p. Dep. CFSTI.

The heat pipe appears to have great potential for determining the total hemispherical emissivities of surfaces. If a heat source is located inside a heat pipe, the heat input to the system is accurately known. All of the heat input must be radiated from the external surface of the heat pipe and if the surface is isothermal, the total emissivity can be determined. The heat pipe, with its two-phase fluid flow, has this ability to maintain isothermal conditions over large areas and provides a simple, accurate method for emissivity measurements. By using various heat pipe containers and plating or spraying the containers with different materials, the emissivities of numerous materials can be estab-

lished. The total emissivities of several different surfaces have been determined over a wide temperature range using a variety of heat pipe sizes and operating fluids. The results indicate that accurate, absolute measurements can be made by this method. (auth)

23194 (MSAR-67-203) EFFECT OF HIGH TEMPERATURE SODIUM ON THE MECHANICAL PROPERTIES OF CANDIDATE ALLOYS FOR THE LMFBR PROGRAM. TOPICAL REPORT NO. 9. ANALYSIS OF HIGH OXYGEN AND HIGH CARBON COLD TRAPS. Rodgers, S. J.; Palladino, C. A.; Wildeman, T. J. (MSA Research Corp., Evans City, Pa.). Dec. 1967. Contract AT(11-1)-765. 73p. Dep. CFSTI.

Two cold traps were removed from operational loops and the contents were analyzed for O_2, C, N_2, H_2, carbon compounds, particle size and metallic impurities. Cold Trap I-C had operated for 1400 hours, and Cold Trap II-O_2 had operated for 2300 hours. Loop I-C had operated with a high carbon environment where part of the main-stream flow was passed through a bed of graphite rods at 1200°F. Loop II-O_2 had operated with a high oxygen environment with the cold trap being operated at 700°F to provide oxygen concentration of ~300 ppM O_2. The oxide was concentrated in the space below the mesh and in the first few inches of the mesh. Cold Trap I-C which operated at 250°F effectively removed hydrogen, while Cold Trap II-O_2 which operated at 700°F did not remove hydrogen. Carbon was found in both cold traps. Cold Trap I-C contained 0.05 pounds of carbon, and Cold Trap II-O_2 contained 0.01 pounds of carbon. It appeared that mesh must be used in a cold trap if carbon is to be removed effectively. Carbon dioxide, C_2H_2 and HCN were found in both traps at significant levels. Traces of methane, ethane, ethylene, carbonyl sulfide, hydrogen sulfide, cyanogen and oxymonocyanogen were found, also. Iron ranging to 1% was found in Cold Trap I-C; maximum iron concentration in Cold Trap II-O_2 was ~0.5%. On the basis of the relative quantities of CO_2, C_2H_2 and HCN detected during analysis, it is assumed that Na_2C_2 or some acetylene-producing compound, such as a carbonyl, is responsible for carburization of austenitic steels. (auth)

23195 (NYO-3363-7(Vol.1)) DESIGN OF LIQUID METAL LUBRICATED BEARINGS. VOLUME 1. DESIGN DATA FOR TILTING PAD BEARINGS IN THE LAMINAR AND TURBULENT FLOW REGIMES. Final Report. Arwas, E. B.; Waldron, W. D. (Mechanical Technology Inc., Latham, N. Y.). Feb. 1968. Contract AT(30-1)-3363. 226p. (MTI-68-TR-6(Vol.1)). Dep. CFSTI.

A 3½ year program was undertaken to study liquid metal lubricated bearings which are particularly important for nuclear powered turbogenerators that use liquid metals as the cycle fluids. Current work on the preparation of detailed design data for such bearings is reported. A comprehensive set of design data is included that covers operation of tilting-pad journal bearings in both the laminar and the turbulent flow regimes. In this design all fluid-dynamic bearing characteristics are tabulated as functions of bearing geometry and operating conditions. The data are presented in normalized form so that it is applicable (within the specified limits on operating conditions) for all bearing sizes and clearance ratios. It covers the full range of generally used bearings, ranging from 3 to 6 pads per bearing, with length-to-diameter ratios from 0.25 to 1 for Reynolds Numbers up to 30,000. The improvements in bearing performance achievable by preloading the bearings for certain conditions of operation are stressed and the design data given covers the range of preload from 0 to 0.5. (L.C.L.)

23196 (NYO-3363-7(Vol.2)) DESIGN OF LIQUID METAL LUBRICATED BEARINGS. VOLUME 2. AN EXPERIMENTAL INVESTIGATION OF NaK LUBRICATED TILTING PAD BEARINGS. Final Report. Waldron, W. D.; Arwas, E. B. (Mechanical Technology Inc., Latham, N. Y.). Feb. 28, 1968. 136p. (MIT-68-TR-7(Vol.2)). Dep. CFSTI.

An experimental investigation was conducted to assess the validity of liquid metal-lubricated bearing design data. Sodium-potassium eutectic was used as the lubricant. Tests were run at 110 to 120°F. The design, selection, and testing of the test rig and sodium-potassium loop are described in detail. The operation of the actual test program, the data generated and its comparison with theory are given. In general, the design data was found to correlate well with the experimental results. Due to the need for special instrumentation for use in the development of process-fluid lubricated bearings for components in reactor sodium systems, calibration tests were performed for a high temperature, inductive type proximity transducer, first at the low ambient test temperatures and then at 500, 700, and 1000°F. Further development is recommended to improve the reliability of this instrumentation in high temperature bearing tests. (L.C.L.)

23197 (ORNL-TM-2073) CALIBRATION OF THE SNAP-10A PUMP AS A MAGNETIC FLOWMETER. Smith, A. M. (Oak Ridge National Lab., Tenn.). Apr. 4, 1968. Contract W-7405-eng-26. 23p. Dep. CFSTI.

A SNAP-10A permanent-magnet pump was installed in an existing flowmeter-calibration test facility and calibrated as a magnetic flowmeter. The pump was calibrated at NaK flow rates of 0.25 to 5.0 gpm and pump inlet temperatures of 200, 400, 600, and 800°F. Calibration curves show that the signal generated in the pump is strongly affected by a temperature difference between the points where the flow signal leads are attached. The lead junctions should be maintained isothermal if the SNAP-10A pump is to provide good flow measurements at low flow rates and temperatures above 200°F. (auth)

23198 (TID-24347) CONDENSER TUBE BUNDLE CONFIGURATIONS FOR 50-MGD AND LARGER DESALINATION PLANTS. Research and Development Progress Report No. 315. Hammond, R. P. (Oak Ridge National Lab., Tenn.); Hunter, J. A.; Sieder, Everett N.; Tomalin, Paul G. (Office of Saline Water, Washington, D. C.). Dec. 1967. 131p. Dep. GPO $0.65.

The design of condensers for large desalination plants of 50-Mgd capacity or more, requires special consideration of the effects of the tube bundle arrangement and configuration. A study was undertaken to identify the tube bundle design parameters which affect heat transfer, pressure losses, and overall performance of the condensers, to review current design practices, and to develop a computer program which can be used to evaluate the design of such large condensers. The development of the computer program is described in detail as well as the application of particular codes for different tube bundle configurations and specific flow conditions. The results of this study should enable proper evaluation of designs for 50-Mgd and larger plants, as well as to provide methods for design. (L.C.L.)

23199 PROBLEMS IN THE SEPARATION OF RADIOACTIVE IODINE VAPOR. Winter, K. Atomwirt., Atomtech., 12: 440-2(Aug.-Sept. 1967). (In German).

Radioactive iodine vapor, because of its physical and biological characteristics, constitutes a source of danger in the exhaust air from nuclear-technical installations. Attempts were made to find a basis for a highly effective iodine separator. From the large number of experiments two effects emerged which were of great significance for the assessment of iodine filter plants. It appeared that the effectiveness of adsorption and chemisorption filters in removing iodine fell, on the one hand, with increasing atmospheric humidity and, on the other, as the iodine concentration at the input became smaller. To fulfill the requirement that the effectiveness should be relatively independent of the input concentration efforts were made to discover an impregnation for the active carbon in carbon filters which would react with the highly fluid methyl iodide to form more viscous substances. Finally very high decontamination factors were attained with a very simple impregnation, potassium iodide, although the mechanism was not in fact that of chemisorption but a new process, isotope exchange. In the present article the iodine filter constructions most commonly used are dealt with from the points of view of separation effectiveness, leakage rates and reliability. (auth)

23200 TECHNIQUE OF PARTICLE SIZE ANALYSIS OF ZIRCON USING THE COULTER COUNTER. Wanless, L. (Associated Lead Manufacturers Ltd., Newcastle-upon-Tyne, Eng.). Trans. Brit. Ceram. Soc., 67: 29- (Feb. 1968).

The use of the Coulter counter as a quick and accurate method for routine determination of particle size distributions of milled zircons with average particle sizes in the range 1.5 to 4 μm was investigated. Effective operation was found to depend on attention to a number of precautions, which are described in detail. Reproducible results can be obtained if these precautions are observed. The ability of the counter to discriminate between samples of zircon of sizes significantly different with respect to ceramic applications was compared with the discrimination of other methods of size determination and shown to be at least as good. A rapid method developed for determining average particle sizes of routine samples involves counting only large particles and comparing these counts with standards. Answers of sufficient accuracy for routine control purposes are obtained in minutes. (auth) (UK)

23201 MACHINES WITH GAS BEARINGS IN NUCLEAR ENERGY. Mech, C. Energ. Nucl. (Paris), 9: 508-14(Dec. 1967). (In French).

The development of uranium hexafluoride gas compressors was a difficult and determining stage in the construction of the Pierrelatte plant. Gas bearings were chosen for the plant compressors. Applications of gas bearings in the nuclear field are discussed. (auth)

23202 DYNAMIC SEAL TECHNOLOGY: TRENDS AND DEVELOPMENTS. PART 1. SEAL TYPES. Decker, Otto (Franklin Inst. Research Labs., Philadelphia). Mech. Eng., 90: 28-33 (Mar. 1968).

Theoretical concepts of dynamic seals for nuclear power and space power systems operating at elevated temperatures and employing liquid metals, gases, or organic fluids are reviewed. Advantages and disadvantages of mechanical face seals, floating or fixed-gap seals, visco seals, and centrifugal seals are evaluated. Seventeen references bearing on the subject are listed. (P.G.C.)

23203 ABSOLUTE MEASUREMENT OF RADIOACTIVITY. Baerg, A. P. (National Research Council, Ottawa). Metrologia, 3: 105-8(Oct. 1967).

Accuracy of radioactivity measurements, especially in metrology, is discussed in terms of current efforts to achieve reproducible results among standards laboratories. This is considered essentially a problem of selecting an absolute method of measurement and defining the experimental requirements in sufficient detail for general use. A further analysis of coincidence counting was made in an attempt to define more clearly the conditions under which this method may provide acceptable accuracy. The variety of methods already in common use for measuring radioactivities suggests that selection of a preferred method is difficult to make unambiguously. However, the choice must be based on previous knowledge of the nature of the decay and the detection apparatus. Intercomparison of different methods does not facilitate the selection. There is nothing to be gained, for example, from an inter-laboratory comparison of a 4π counter result with that of an absolute coincidence measurement on ^{60}Co. The definition of mutually acceptable experimental procedures is as important as the selection of a basic method of measurement. Various other examples are cited. (BBB)

23204 WATER DESALTING COST: PRESENT AND FUTURE. Brice, D. B. (International Atomic Energy Agency, Vienna). pp 403-21 of Isotope and Radiation Techniques in Soil Physics and Irrigation Studies. Vienna, International Atomic Energy Agency, 1967.

From Symposium on the Use of Isotope and Radiation Techniques in Soil Physics and Irrigation Studies, Istanbul. See STI/PUB-158; CONF-670641.

The rapidly increasing demands for fresh water have led to intensified efforts to develop the desalination of saline water. At present some of the more promising processes for desalination of sea water are multi-stage flash distillation and long-tube vertical evaporation. These processes are described. For desalination of brackish water the electrodialysis process is normally selected. A modern multi-stage flash-distillation plant requires a thermal energy input of 50,000 or more kcal/m^3. Thus, the large-scale desalination of saline water will require an enormous amount of energy. Also, a substantial reduction in the cost of desalted water could be realized if an inexpensive source of energy were available. It is in this respect that nuclear energy offers considerable potential for the future of desalination. Developments in nuclear reactors are described. By the end of 1966 the nuclear reactors in operation had a total capacity of 9000 MW(e). It is anticipated that this capacity will increase to 25,000 MW(e) by 1970 and 100,000 MW(e) by 1975. Improvements in reactor technology and decrease in nuclear fuel costs are expected to bring the cost of steam to about 70 US cents per million kcal by the mid 1970s, to 48 to 60 US cents per million kcal with advanced converters in the late 1970s and to 24 to 40 US cents per million kcal with advanced converters in the late 1970s and 24 to 40 US cents per million kcal with breeder reactors by the early 1980s. The maximum evaporator brine temperature in a multi-stage flash-distillation plant is at present limited by economic means of scale control to about 120°C, whereas the generating costs of electric power plants are lowest when the steam is produced at higher temperatures. This leads to economic advantages in combining the production of water and power. The ratio of water-to-power output for dual-purpose nuclear plants is limited at present to about 0.3 to 0.8 Mgd/MW(e), depending on the type of reactor. Projected desalted water costs from large dual-purpose plants have been estimated as low as US \$0.06/m^3. Further into the future, with improved technology and from very large plants, the cost envisaged is in the neighborhood of US \$0.03/m^3. (auth)

23205 FACTORS AFFECTING THE ABILITY OF AGRICULTURE TO PAY IRRIGATION-WATER COSTS. Hagood, M. A. (Food and Agriculture Organization of the United Nations, Rome). pp 423-7 of Isotope and Radiation Techniques in Soil Physics and Irrigation Studies. Vienna, International Atomic Energy Agency, 1967.

From Symposium on the Use of Isotope and Radiation Techniques in Soil Physics and Irrigation Studies, Istanbul. See STI/PUB-158; CONF-670641.

There are no universally acceptable standard criteria for determining how much agriculture can pay for irrigation water. Justification of cost will depend upon the country's need to develop its soil and water resources for food, for international trade, and for its cumulative effect on other industries in comparison with other possible uses and their overall contributions to the economy. Social and political conditions often have as much or more influence on development cost decisions than do strictly economic analyses. Many studies indicate that US \$0.10/1000 US gal is an upper limit of acceptable costs for developing irrigation water at present economic levels. Under private development and on projects where water users must pay total water costs, methods are available for making feasibility budgets based on present prices. Because of inflation, world food shortage, recessions, future population and other unknown factors, it is hazardous to predict how much farmers or agriculture can pay for irrigation water. Better utilization of water available now offers opportunities for "developing" sources at costs much less than those for sources such as sea-water conversion. (auth)

23206 LIGHT SOURCES FOR MARKERS, BUOYS, AND THE LIKE. Guthrie, David Graham (to Saunders Roe and Nuclear Enterprises Ltd.). British Patent 1,108,398. Apr. 3, 1968. Filed Aug. 19, 1965.

The design of a self-luminous light emitting unit is given. A sealed glass tube internally coated with a phosphor, and containing a gaseous radioisotope is wound into a helix where the spacing between the turns is approximately equal to the outside diameter of the tube. (J.C.W.)

23207 ELECTRON DISCHARGE DEVICE. (to Ford Motor Co., Ltd.). British Patent 1,109,023. Apr. 10, 1968. Priority date Sept. 30, 1965, United States.

A high-energy electron source for curing coating materials by electron-initiated polymerization is described. The material to be irradiated is separated from the electron source by a distribution chamber containing a gaseous medium having an average density substantially below that of air at one atmosphere pressure. (W.H.K.)

Heat Transfer and Fluid Flow

Refer also to abstracts 23193, 23195, 23198, 23710, 24956, 24960, 24961, 24971, and 25005.

23208 (LA-DC-9026) HEAT PIPE STARTUP DYNAMICS. Cotter, T. P. (Los Alamos Scientific Lab., N. Mex.). [nd]. 5p. (CONF-671045-2). Dep. CFSTI.

From IEEE Thermionic Conversion Specialist Conference, Palo Alto, Calif.

Transient modes of heat pipe startup are described. The heat flux-temperature states, the flow properties during startup, and the various mechanisms which may inhibit successful startup are discussed quantitatively. (auth)

23209 (LA-DC-9027) HIGH-PERFORMANCE HEAT PIPES. Kemme, Joseph E. (Los Alamos Scientific Lab., N. Mex.). [1967]. Contract W-7405-eng-36. 4p. (CONF-671045-4). Dep. CFSTI.

From IEEE Thermionic Conversion Specialist Conference, Palo Alto, Calif.

The heat transfer capability of a heat pipe depends to a large extent on the wick structure. Composite wicks are being investigated in heat pipes having several axial channels covered with screen. High heat transfer rates have been obtained with a very fine screen cover and relatively large channels. The fine screen cover provides a large capillary force for fluid circulation. It also suppresses liquid entrainment which might otherwise limit heat transfer. The protected channels provide a low impedance path for liquid return. It is shown that all of these wick functions are important and need to be considered in the design of high performance heat pipes. (auth)

23210 (LA-DC-9028) HEAT PIPE PERFORMANCE IN A SPACE ENVIRONMENT. Deverall, J. E.; Salmi, E. W. (Los Alamos Scientific Lab., N. Mex.). [nd]. Contract W-7405-eng-36. 4p. Dep. CFSTI.

From IEEE Thermionic Conversion Specialist Conference, Palo Alto, Calif.

The unusual thermal characteristics of the heat pipe indicate that it has great potential for the solution of heat transfer problems in satellites. In order to demonstrate that heat pipes will

function normally under space conditions, a water heat pipe was launched into an earth orbit by an Atlas-Agena vehicle to determine the effect of a zero-gravity field on its operation. A second experiment was conducted in which a similar heat pipe was subjected to typical sinusoidal and random vibrations experienced by a satellite during the missile launch period. The results of the experiments indicate that heat pipes are suitable for space applications. (auth)

23211 (NYO-2930-13) TURBULENCE IN FLOWS CONTAINING SUSPENDED SOLIDS. Technical Report No. 118-MAE-F. Peskin, Richard L.; Baw, Philemon S. H. (Rutgers-The State Univ., New Brunswick, N. J. Dept. of Mechanical and Aerospace Engineering). Jan. 1968. Contract AT(30-1)-2930. 79p. Dep. CFSTI.

Following the Reynolds averaging method of turbulent analysis and Pai's approach to the problem of turbulent flow in a circular pipe, the solid-phase density distribution in gas-solid turbulent pipe flow is found to be controlled by the correlation of axial and transverse particle velocity. Sample measurements of the solid-phase density profile were obtained by optical techniques. An analysis of the apparent particle energy spectrum function was undertaken in addition to the analysis of the effect of particles on the fluid energy spectrum. In universal equilibrium range, the energy spectrum function, E(k), which is obtained by using Pao's hypothesis, decreases at a higher rate than for the case of pure air as k increases. (auth)

23212 (ORNL-TM-2113) ENTRAINED-FLUIDIZED-BED SYSTEM FOR PYROLYTIC CARBON COATING OF MICROSPHERES. Flamm, H. J. (Oak Ridge National Lab., Tenn.). Apr. 1968. Contract W-7405-eng-26. 39p. Dep. CFSTI.

A system for pyrolytic carbon coating of microspheres, in which particulate solids are entrained by an upward flowing gas stream and conveyed through a chimney concentric to this stream, was investigated in search of simple, economical, and potentially large-scale processes. The solids are disentrained above the chimney and return to an annular section external to the chimney for transient storage and reentrainment from the lower section, which is tapered toward a single gas inlet. The reaction zone remains independent of bed volume or height changes. Smooth conveying was demonstrated over a wide range of conditions in transparent models at room temperature, using glass beads, iron shot, and lead shot of various sizes as substitute materials and air as the entrainment medium. Slugging or bubbling was never observed. Contrary to fluidized-bed technology, in which the gas flow required for incipient fluidization increases as the square of the particle diameter, conveying rates in the described system increased with the particle diameter for a given gas flow. Based on the room-temperature model studies, a high-temperature entrained-bed system was built to adapt to an existing fluidized-bed furnace system. Pyrolytic carbon coating experiments with an entrained bed were successfully performed. (auth)

23213 (RLO-1954-2) AN INVESTIGATION OF TURBULENT FLOW IN A ROUGH PIPE. Progress Report, May 1, 1967-April 30, 1968. Townes, Harry W. (Montana State Univ., Bozeman. Dept. of Mechanical Engineering). Feb. 14, 1968. Contract AT(45-1)-1954. 27p. Dep. CFSTI.

The heat transfer coefficient between a solid surface and a moving fluid may be increased by roughening the surface. An investigation was made to determine the basic changes caused by the roughness to the turbulent flow field, the changes which, in turn, cause the increase in heat transfer. In order to conduct the investigation a flow system is necessary. The basic flow system which has been designed and constructed consists of a circular pipe 1 ft in diameter and 70 ft long, an entrance section, fan, return line, and heat exchanger. Air is used as the working medium. Progress to date has been the design and construction of the flow loop, the selection and purchase of the equipment necessary to carry out the investigation, calibration of the hot wire anemometer linearization circuits, a determination of the hot wire probe cross response characteristics, writing of the computer programs necessary for data reduction and the measurement of several mean velocity profiles in a smooth pipe. (auth)

23214 (K-Trans-28) FLOW STUDIES WITH SWEPT COMPRESSOR CASCADES WITH COMPRESSIBLE SUBSONIC FLOW. Stark, U. (Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Brunswick (West Germany). Institut fuer Aerodynamik). Translated for Oak Ridge Gaseous Diffusion Plant, Tenn., from research report 67-09. 67p. Dep. CFSTI. JCL $6.60 fs, $2.27 mf.

The results of experimental investigations on swept compressor cascades at high subsonic Mach numbers (M = 0.3 to 0.9) are presented. In order to determine the aerodynamic behavior of swept compressor cascades, measurements of pressure loss coefficients, turning angles and pressure rise coefficients have been carried out with a straight and two swept compressor cascades with sweep angles of 20 deg and 40 deg in a high-speed cascade wind tunnel. These wake measurements at mid-span position show the fundamental influence of the sweep on compressor cascade performance, which consists in a decrease of the turning angles and pressure rise coefficients and in an increase of the critical Mach number. Measurements of blade-surface pressure distributions in several wall-parallel sections show that depending on the sweep angle, φ, the effective inlet angles and the blade-surface pressure distribution of these sections are influenced by the tunnel side-walls. (auth)

Isotope Technology

Refer also to abstracts 23140, 23143-23145, 23152-23162, 23206, 23406, 23593, 23800, and 25032.

23215 (AERE-M-1167) A TECHNIQUE FOR LOADING MALONEY SPHERES WITH HIGH-ACTIVITY ^{24}Na UNDER FIELD CONDITIONS. Metcalfe, B.; Ctlet, R. L. (United Kingdom Atomic Energy Authority, Wantage (England). Research Group). Mar. 1963. 10p. Dep. CFSTI. UK.

A technique is described which permits the loading of ^{24}Na solution into Maloney spheres under field or on site conditions. Consideration has been given to the required simplicity and safety of such an operation and the suggested technique has been successfully adopted in a practical isotope application. (auth)

23216 (AI-AEC-12642) LARGE RADIOISOTOPE HEAT SOURCE CAPSULE (LRHSC). Second Quarterly Progress Report, October-December 1967. (Atomics International, Canoga Park, Calif.). Jan. 15, 1968. Contract AT(29-2)-2338. 141p. Dep. CFSTI.

Progress is reported on the Large Radioisotope Heat Source Capsule (LRHSC) Program. Planning and control documentation were released including the final weld development plan and the Quality Assurance Plan. Documentation methods for all phases of the program were established and implemented. Analytical support to the test program, including work directed at thermal environments, chill block requirements and the interference fit tooling requirements is described. Assembly and test tooling and fixture design were completed, released and fabrication initiated. The warm back extrusion process for producing deep T-111 cups was demonstrated; two types of impact absorbers were evaluated; TIG welding at 1 psia was done; and a heat treating study of Ta-10W and T-111 was completed. Coating development for application of the Al_2O_3 barrier coating continued. A process for applying α phase Al_2O_3 has been developed. Four coupon compatibility stacks were tested. The 100 hour test at 2000°F, and the 10 hour test at 2250°F were completed. The 1000 hour test at 2000°F and the 10 hour test at 2500°F were initiated. The significant results found to date are a general incompatibility between iron titanate and both Ta-10W and T-111. Effort was expended on the creep test systems, test techniques and instrumentation. A final approach which meets both the temperature control requirements and the visual observation requirement was verified. (auth)

23217 (CONF-670445-, pp 18,33-54) UNDERSEA RADIOISOTOPE POWER SUPPLY. Carney, H. C. (Aerojet-General Corp., San Ramon, Calif.). 22p.

The results and current status of a program to develop low-power radioisotope thermoelectric generators for marine applications are discussed. A 1-watt(e) Undersea Radioisotope Power Supply (URIPS) has been designed, fabricated, and tested. Extensive parametric studies were performed to select optimum design characteristics; typical parameters investigated were: radioisotope and chemical fuel form, thermoelectric material, fuel capsule L/D ratio, shield material and geometry, and operating conditions. The design emphasizes high reliability and low cost, but considerable emphasis was placed on adaptability to meet a wide spectrum of user requirements. URIPS is designed to provide a steady power output for a minimum of five years at ocean depths up to 20,000 feet. (auth)

23218 (COO-1239-15) DIFFRACTOMETRY WITH ^{55}Fe AND BETA EXCITED X-RAY SOURCES. Interim Report, March 1, 1964-August 31, 1965. Preuss, Luther E.; Toothacker, William S.; Bugenis, Claudius K. (Edsel B. Ford Inst. for Medical Research, Detroit, Mich. Div. of Nuclear Spectroscopy and Radiation Physics). Aug. 1967. Contract AT(11-1)-1239. 23p. Dep. CFSTI.

An evaluation of analytical diffraction using ^{55}Fe and beta stimulated x-radiation was undertaken. Calculation of theoretical signal levels for intermediate source strengths indicated that the intensity of the diffracted beam was in the range of low level counting meth-

ods for ^{55}Fe x-radiation and below this level with the beta stimulated x-ray sources, it being a fraction of a count per minute for the latter case. The initial diffraction experiments were carried out using x-ray counting systems and resulted in no detectable beam for the assay techniques used. A second study using methods of multichannel analysis clearly demonstrated the low level diffracted beam from a 100 mCi ^{55}Fe source. The three primary diffracted beams from LiF were shown. Intensity levels were of the order of predicted values. Earlier work had predicted demonstrable diffraction using beta excited x-ray sources fabricated with 2 to 20 mCi of beta emitter, but had not shown this experimentally. Promethium-147 beta activity levels from 50 to 250 mCi were tested with polycrystalline powder samples for diffraction by gross counting techniques. No demonstrable diffraction was obtained. Higher levels of ^{147}Pm activity along with spectral analysis are proposed as a second phase for this study. Single crystal diffraction and beta excited sources of very high level activity may result in diffraction of a low intensity, but detectable beam (detectable by multichannel analysis techniques and possibly by less sophisticated assay methods). (auth)

23219 (DLR-MITT-66-07, pp 73-82) ENERGIEVERSORGUNG DURCH RADIONUKLIDE. (Energy Production by Radionuclides). Hannemann, D. (Entwicklungsring Nord, Bremen (West Germany)). (In German).

An isotope battery using ^{90}Sr in the form of strontium oxide is described in detail. The energy converter, the construction design, the heat isolation, heat irradiation, and radiation protection are discussed. (J.S.R.).

23220 (IA-1128, pp 160-8) APPLICATIONS OF RADIOISOTOPES. (Israel Atomic Energy Commission, Tel Aviv).

Activities during 1966 on the applications of radioisotopes were focused on the continuation of the extensive research program for the irradiation of food and agricultural products. A portable irradiator of the B.N.L. shipboard irradiator type was obtained from the USAEC for one year. This addition to the irradiation facilities greatly contributes to speeding up research work in those projects where high radiation doses are required. A detailed survey of the use of disposable sterilized items in the Hillel Yaffe Hospital was completed, as part of a program to promote use of locally produced radiation sterilized disposable items in Israeli hospitals and Sick Fund dispensaries. An economic study of the feasibility of using irradiation to delay sprouting of potatoes and onions was prepared under a grant from the Israel National Research Council. (auth)

23221 (MLM-1455) STABLE GASEOUS ISOTOPE SEPARATION AND PURIFICATION: OCTOBER-DECEMBER 1967. (Mound Lab., Miamisburg, Ohio). Apr. 19, 1968. Contract AT-33-1-GEN-53. 43p. Dep. CFSTI.

Carbon isotope separation by distillation, mass diffusion, and chemical conversion was studied. Separation of helium, neon, argon, and krypton isotopes by thermal diffusion is described. Two-bulb thermal diffusion factor determination, thermal gradients in the low-temperature Trennschaukel, temperature gradients in the high-temperature Trennschaukel, isotope separation in a dissociating gas, xenon transport coefficients, turbulence in thermal diffusion, transient performance of multicomponent isotope separation cascades, and thermal transpiration are discussed. (M.C.G.)

23222 (MND-3322-25(Vol.1)) SNAP 21A TEN-WATT DEEP SEA ISOTOPIC POWER SUPPLY. Volume I. Summary Report: Phase I, March 1964-June 1965. (Martin Co., Baltimore, Md. Nuclear Div.). June 30, 1965. Contract AT(30-1)-3322. 148p. Dep. CFSTI.

A summary is given of accomplishments achieved during the SNAP 21A Phase I development program. These include results for the complete effort as well as a concise data summary for the recommended system design. The generator system is described in detail and pertinent supporting test data on all component development tests undertaken during Phase I are evaluated. Greater detail has been applied to the evaluation of the thermoelectric couple and the finally selected couple configuration. Initial test data for an electrically heated full-scale operating model which was assembled using development test components are also included. (L.C.L.)

23223 (MND-3322-25(Vol.2)) SNAP 21A: TEN-WATT DEEP SEA ISOTOPIC POWER SUPPLY. Volume II. Summary Report, Phase I, March 1964-June 1965. (Martin Co., Baltimore, Md. Nuclear Div.). July 23, 1965. Contract AT(30-1)-3322. 294p. Dep. CFSTI.

A summary is given of accomplishments achieved during the SNAP 21A Phase I development program. Included is a complete and detailed historical documentation relating to design, development tests, laboratory test procedures, and test data analysis for all components. Several appendixes relating to significant analytical studies are also included. (L.C.L.)

23224 THERMAL CONTROL IN DUAL TEMPERATURE SYSTEMS. Spevack, J. S. Canadian Patent 780,298. Mar. 12, 1968.

An economical dual temperature exchange process for the production of heavy water is described. Deuterium is exchanged between H_2S and H_2O by countercurrent flow in a series of hot and cold towers. Direct and indirect heat exchangers are employed for maximum use of heat transfer in process streams to produce desired temperature changes for optimum yields. Heat of vaporization and condensation are recovered and used for the process following such as stripping dissolved gas from waste liquor, humidification of another gas stream, or dehumidification. (F.S.A.)

23225 LONGITUDINAL AND LATERAL RESPONSE OF MULTICHANNEL FOCUSING COLLIMATORS. Popovic, S. (Univ. of Zagreb); Mallard, J. R. Int. J. Appl. Radiat. Isotop., 19: 303-12(Apr. 1968).

A method of calculating the response along the axis of a multihole focusing collimator and also the lateral response at the geometrical focus is described. The geometrical efficiency for a circular plane source of uniform distribution of radioactivity and of radius equal to the resolution diameter was also determined approximately. Crystal attenuation was determined approximately by taking into account the path length in the crystal of a gamma ray from a point source through the center of the overlapping area resulting by projecting the entrance pupil on the plane of the exit hole near the crystal face. Experimental measurements of the longitudinal responses obtained with point sources of ^{131}I, ^{123}I, and ^{125}I were in good agreement with theoretical calculations for both circular and hexagonal arrangement of holes. Theoretical and experimental curves for the lateral response are also in good agreement. The lateral response in any plane perpendicular to the collimator axis was derived, but requires a computer program for evaluation. (auth)

23226 ISOTOPES AND RADIATION. Nucl. News, 11: 42-6 (Jan. 1968).

Commercial use of radioisotopes is reviewed. The major categories of the radioisotope industry discussed are producers, processors, source fabricators, and equipment manufacturers. Commercial radiation processing applications are also discussed. (D.H.M.)

23227 ISOTOPIC THERMOELECTRIC GENERATORS. Atom, 137, 65-7(Mar. 1968).

British-built generators are in operation at a number of locations in the seaways of Europe, operating as power supplies for marine navigational aids. A summary is given of papers presented at the January 1968 colloquium in London on the RIPPLE (Radioisotope Powered Prolonged Life Equipment) program and its commercial applications. (UK)

23228 REPLENISHMENT MODEL FOR RADIOACTIVE NUCLIDE GENERATORS. Emmons, Hamilton (Cornell Univ., Ithaca, N. Y.). Manage. Sci., 14: 263-74(Jan. 1968).

The nuclide generator is a convenient method of making short-lived nuclides available far from the source of production. It may be employed when the desired nuclide is a natural decay product (or daughter) of a longer-lived radionuclide (the parent). The procedure used is to keep in stock a supply of the parent nuclide, and periodically elute (that is, separate, or milk off) the daughter for use, leaving the parent to generate a fresh supply. The technology of such milking systems is making rapid progress, and today a variety of short-lived nuclides is available to hospitals in this way at moderate cost. The inventory problem for such exponentially decaying substances is considered. Methods are proposed for finding the optimizing replenishment size when the reorder point, replenishment cost function, and other parameters are given. The reorder point is determined by certain medical requirements which give rise to a rather complicated model. A simple method is presented for finding close bounds on the required solution. (BBB)

23229 DECREASE OF THE SEPARATION POWER UNIT COST OF AMERICAN GASEOUS DIFFUSION PLANTS. Blum, J. M. Energ. Nucl. (Paris), 9: 517-21(Dec. 1967). (In French).

The United States AEC has published a new table of the separation power units necessary for various possible enrichments of U as a function of the new cost of the separation power unit fixed at $26 for a standard reject rate of the plants of 0.2%. The cost of enriched U in the United States is analyzed on the basis of plant optimization and the results of this new cost table. (J.S.R.)

23230 SEPARATION OF U ISOTOPES IN FRANCE AND IN THE WORLD. Pecqueur, M. (CEA, Paris). Energ. Nucl. (Paris), 9: 480-8(Dec. 1967). (In French).

The development of the Pierrelatte installation and the history of the isotopic separation of U in France and in the world are outlined. The civil and military reasons for the separation of U isotopes are given. The U isotope separation developments of the United States, England, Russia, China, and France are briefly reviewed. The principal separation procedures—electromagnetic separation, thermal diffusion, the Becker method, and centrifugation—are described in principle. The gaseous diffusion procedure is described in slightly more detail. The Pierrelatte installation based on the gaseous diffusion procedure is described. Technological difficulties in the design and construction of this installation were connected with the properties of uranium hexafluoride, the barrier, and the compressor and its tightness. The solutions used in each of these areas are indicated. (J.S.R.)

23231 SOME TECHNOLOGICAL AND EXPERIMENTAL PROBLEMS INVOLVED IN THE CONSTRUCTION OF THE GASEOUS DIFFUSION UNIT AT PIERRELATTE. Energ. Nucl. (Paris), 9: 489-95(Dec. 1967). (In French).

Preliminary surveys for the construction of the plant at Pierrelatte, carried out by the French Atomic Energy Commission, or under its direction, have involved a wide range of technical fields. Some of the major technological and experimental problems dealt with in this phase of surveys for the plant are reviewed, and the wide-ranging influence of a scheme like Pierrelatte on the development of advanced techniques in industry is indicated. (auth)

23232 INDUSTRIAL APPLICATIONS OF RADIO-ACTIVE TRACERS AND SMALL RADIATION SOURCES. Jervis, R. E. (Univ. of Toronto). 6p. of International Conference and Exhibition on a World Review of Nuclear Reactors and Radioisotopes, Montreal, Quebec, Canada, May 28–31, 1967. Toronto, Canadian Nuclear Association, 1967. (CONF-670522–17; 67-CNA–403).

Substantial benefits are being derived through radioisotope applications for process and quality control in industry, for analysis and for research and development. While there has been a considerable world-wide increase in radioisotope utilization (circa 25 to 30% per annum), several Canadian organizations have found novel and attractive applications recently and there are indications of more Canadian involvement in the near future in fields that have been pioneered here since radioisotopes first became available. (auth)

23233 PRESENT AND FUTURE APPLICATIONS OF LARGE RADIATION SOURCES IN INDUSTRY, AGRICULTURE, AND MEDICINE. Jefferson, S. (United Kingdom Atomic Energy Authority, Wantage, Eng.). 7p. of International Conference and Exhibition on a World Review of Nuclear Reactors and Radioisotopes, Montreal, Quebec, Canada, May 28–31, 1967. Toronto, Canadian Nuclear Association, 1967. (CONF-670522–16; 67-CNA–402).

The salient properties of radiation processing are reviewed. Examples surveyed and briefly discussed are: inactivation of anthrax in bales of goat hair, sterilization (without heat) of several medical items, prevention of deterioration in stored grains, elimination of risk of Salmonella infection from livestock food, promotion of chemical reactions such as manufacture of ethyl bromide and biodegradable detergents, improvement in properties of certain polymers. A table summarizes the larger plants operating or under construction. (F.S.A.)

23234 INVESTIGATION OF THE FILTERS OF DIESEL-POWERED VEHICLES WITH RADIOISOTOPES. Fodor, J.; Keomley, G. Gep, 18: 179-86(1966). (In Hungarian).

Methods of measurement using radioisotopes were developed in Hungary for investigations on fuel, lubricating oil, and air filters. Quartz powder labeled with ^{110}Ag isotope was made to pass through the fuel and lubricating oil filters subject to investigation; the variations in the activity of the flowing suspension were measured and inferences on filter efficiency were drawn. The parameters of numerous types of filters were established from the results of investigations on diesel oil filters as a result of which the general introduction of a Hungarian-made two-well filter with felt and paper elements has been suggested. Improvement of the efficiency of lubricating oil filters would justify the enlarging of the discharge orifice in the filter casing. Air filters were tested under road conditions by an indirect process; their efficiency was determined by the rate of wear of a radioactive piston ring mounted in the engine; a charge of Raschig rings was found to considerably improve efficiency. (Hung. Tech. Abstr.)

Materials Testing

Refer also to abstracts 23184, 23758, 23768, and 25227.

23235 (IN–1131, pp 116-22) TECHNIQUES IN NONDESTUCTIVE TESTING. (Idaho Nuclear Corp., Idaho Falls).

Radiographic standards were used as a means of measuring fuel homogeneity in test reactor fuel plates. The fabrication process for the standards consists of blending aluminum powder with specified amounts of UAl_3 powder, then compacting. The green compact is put into a restraining aluminum picture frame without cover plates, heated to 500°C, then rolled with a 20% reduction per pass to a total 8 to 1 reduction. Fuel particles are occasionally observed in the end regions of the ATR fuel plates between the cladding and picture frame. In the routine radiography technique, it is desirable to determine the smallest fuel particle that can be seen. A feasibility study was conducted using UAl_3 depleted fuel. Individual particles measuring 0.0017 inch and larger can be observed. (J.C.W.)

23236 (INR–856/XIV/PS) ULTRADZWIEKOWE BADANIA PRZYLEGANIA KOSZULKI DO RDZENIA Z METALICZNEGO URANU. CZESC I. (Ultrasonic Bond Testing Between Tubes and Metallic Uranium Core in Nuclear Fuel Elements. Part I). Pawlowski, Z.; Wiaderny, M. (Institute of Nuclear Research, Warsaw (Poland)). 1967. 41p. (In Polish). Dep.

The ultrasonic immersion testing of nuclear fuel elements is described. It is shown that the ultrasonic method of testing makes it possible to detect not only the unbonding between tube and metallic uranium core, but traces on the oscilloscope screen give information on the internal defects, the density and porosity of metallic uranium core. The conclusion on these two latter inhomogeneities could be drawn from ultrasonic velocity and attenuation measurements. The principles for the interpretation of oscilloscope traces as well as characteristic oscilloscope traces connected with different defects are given. (auth)

23237 ANTI-SHOCK PROPERTIES OF FERRO-CONCRETE CONTAINERS FOR OCEAN RADIOACTIVE-WASTE DISPOSAL. Akatsuka, Yuzo; Seki, Hiroshi. Kowan Giken Shiryo, No. 28, 20-52(Apr. 1967). (In Japanese).

Drop tests were made on hollow ferro-concrete containers in order to investigate the antishock properties of such containers in ocean disposal of radioactive waste. The containers tested were two types: the closed type in which the outside hydraulic pressure was sustained by the ferro-concrete shell itself; and, the internal and external pressure equilibrium type in which the external pressure was not applied to the container by a special means (either by a valve or an adhesive layer between the inside container wall and its lid). The shapes of the former type were spherical, oval and cylindrical, while the latter were cylindrical. Strain gages were imbedded in all containers, and they were dropped onto a massive concrete plate from the heights of 1 to 3 m. When dropped on the concrete plate maximum strains of $^1/_{1000}$ to $^3/_{1000}$ sec. were caused by the shock. The closed-type containers were subjected to a shock, equivalent to dropping into a 2000 m deep ocean. The shock strains were about 180×10^{-6} in both tension and compression. These containers can be considered as having sufficient antishock properties for dropping on the sea-bed rock. In the equilibrium-type containers, considerable cracks occurred, and damage was caused to both the upper and lower ends. (NSA of Japan)

23238 VOID FRACTION MEASUREMENT BY THE GAMMA-RAY ATTENUATION TECHNIQUE. II. EXPERIMENTAL RESULTS. Lupoli, P. (Comitato Nazionale per l'Energia Nucleare, Rome). Calore, 38: 391-8(1967). (In Italian).

Equipment was set-up for measuring the density of a two-phase mixture by the γ-ray attenuation method. The technique was evaluated on plexiglas mock-ups in rectangular, tubular and annular test sections. The purpose of the measurements was to find out the most important values related to the maximum permissible counting rate, measurement errors, calibration curves and traversing technique. (tr-auth)

23239 PHYSICS AND NONDESTRUCTIVE TESTING. Proceedings of the Symposium held at Dayton, Ohio, September 29–30, October 1, 1964. McGonnagle, W. J. (ed.). New York, Gordon and Breach, Science Publishers, Inc., 1967. 573p. $32.00. (CONF-748).

Separate abstracts were prepared for four of the nineteen papers presented. One paper was previously included in NSA as 18: 45169. Fourteen papers were not within the scope of NSA. (B.G.D.)

For abstracts of individual papers see: 23240–23242 and 23365.

23240 ULTRASONIC NONDESTRUCTIVE COATING EVALUATION. Lawrie, W. E. (IIT Research Inst., Chicago). Contracts

AF33(616)-6936; AF33(657)-8938; NObs 84575; AT(11-1)-578. pp 343-71 of Physics and Nondestructive Testing. McGonnagle, W. J. (ed.). New York, Gordon and Breach, Science Publishers, Inc., 1967.

From Symposium on Physics and Nondestructive Testing, Dayton, Ohio. See CONF-748.

Investigation of ultrasonic nondestructive methods of evaluating protective coatings on refractory metals has resulted in the development of several techniques capable of general applicability. One such method depends upon a nonlinear interaction between high and low frequency ultrasonic waves at an imperfect bond. The low frequency wave perturbs the coating–metal interface at unbonded regions and produces modulation of a high frequency transmitted wave. Ultrasonic imaging methods are used to display regions of coating unbonds. The system is discussed in terms of the transducer radiation pattern and the diffraction pattern of the defect. Rayleigh wave applications to coating evaluation will also be discussed. The unique properties of Rayleigh waves restrict the ultrasonic energy to the coating or to the coating and a thin layer of the substrate. (auth)

23241 BARKHAUSEN EFFECT AND ITS APPLICATION IN NONDESTRUCTIVE TESTING. Leep, R. W. (Los Alamos Scientific Lab., N. Mex.). pp 439-53 of Physics and Nondestructive Testing. McGonnagle, W. J. (ed.). New York, Gordon and Breach, Science Publishers, Inc., 1967.

From Symposium on Physics and Nondestructive Testing, Dayton, Ohio. See CONF-748.

A review of information concerning the Barkhausen effect is presented. Observations of Barkhausen noise in steel Charpy specimens as affected by cold work, irradiation, and heat treatment are discussed. There is evidence that Barkhausen noise measurements can yield information about changes in the structure of ferromagnetic materials. (J.R.D.)

23242 NUCLEAR NONDESTRUCTIVE COATING EVALUATION. Oestreich, M. D. (IIT Research Inst., Chicago); Loewe, W. E. pp 523-60 of Physics and Nondestructive Testing. McGonnagle, W. J. (ed.). New York, Gordon and Breach, Science Publishers, Inc., 1967.

From Symposium on Physics and Nondestructive Testing, Dayton, Ohio. See CONF-748.

One technique which can be used to determine the thickness of thin coating or sheet materials is beta particle scattering. When beta particles penetrate a material, several interactions occur. The beta particles will cause ionization of the atoms in the material, will be backscattered by the nuclei in the material, will be scattered by atomic electrons, and will produce bremsstrahlung (photo radiation) by a radiative loss of energy. The relative predominance of each of these interactions is a function of both the effective atomic number of material and the energy of the electron. For a constant beta particle energy, the amount of backscattering is dependent on the square of the atomic number of the scatterer and the mass of the material doing the scattering, up to some maximum value which is dependent on the maximum beta energy. These two properties of the backscattering interaction permit its use as an efficient and sensitive method of determining the thickness of a thin layer. Preliminary experiments have demonstrated that coating thicknesses as small as $\frac{1}{20}$ mil can be determined when the difference in atomic number between coating and substrate is as little as unity. Techniques to permit thickness determination of individual layers in multilayer coatings on refractory metals are being developed. One method utilizing the backscattering intensity of a filtered beta spectrum has been demonstrated capable of measuring the thickness of three-layer simulated coatings. In a second method, the continuous beta particle energy distribution from a radioisotope is separated magnetically so that monoenergetic radiation can be backscattered. This scattered radiation is then analyzed spectrally to determine the coating layer thickness. Additional techniques to determine the properties of coatings being studied include various autoradiograph methods to determine total coating thickness as well as cracks and voids. (auth)

Protective Structures

23243 (NVO-99-33) SPECTRAL MATRIX METHOD OF DAMAGE PREDICTION: DESCRIPTION AND STATUS. Blume, John A. (Blume (John A.) and Associates Research Div., San Francisco, Calif.). Mar. 1968. Contract AT(26-1)-99. 27p. Dep. CFSTI.

A procedure is described for the orderly, standardized prediction of damage in a wide range of structures subjected to ground motion from underground nuclear events or from earthquakes. The Spectral Matrix Method includes consideration of the frequency distribution of ground motion and corresponding structural response, the distribution of natural frequencies for various kinds of structures, foundation materials, structural conditions, and construction practices and standards. Probabilistic aspects are also considered. Calculations for a typical application are shown. The method is suited to either computer or manual processing. (auth)

Radioactive Material Handling

Refer also to abstracts 23142, 23199, and 23237.

23244 (BNWL-544) SOLIDIFICATION OF HIGH LEVEL WASTES. PART V. A FACTORIAL STUDY OF THE EFFECT OF VARYING THE CONCENTRATION OF THE COMPONENTS OF PUREX TYPE WASTE ON THE PROPERTIES OF PHOSPHATE SOLIDS. APPENDIX. RESPONSE SURFACE STATISTICAL ANALYSIS. Barton, G. B.; Weed, J. A. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Jan. 1968. Contract AT(45-1)-1830. Dep. CFSTI.

A statistically designed and interpreted plan for examining the effects of changing the concentration of some of the individual components of Purex-type wastes converted to phosphate solids is presented. The components and range over which they were varied were: sodium 0.45 to 0.90M, aluminum 0.03 to 0.13M, iron 0.06 to 0.26M, chromium 0.012 to 0.052M, nickel 0.006 to 0.026M, fission products 836 to 11,290 MWd/MT of uranium, and phosphate to give M/P ratios of 2.5 to 1.7. Three levels of each component were tested and the whole subjected to statistical analysis of the results of measuring the drip temperature and solubility of the various materials prepared. The materials were examined both in a chill cast condition and after slow cooling at a rate of 1°C/min. From these results it was concluded that the statistically designed plan gave results that could be represented by equations that fairly well described the system. From these equations, one could suggest areas for further examination if one were seeking a particular range of the drip temperature or solubility. Changes in composition of one component interact with the remaining components, thus simple rules of thumb are not forthcoming. Most phosphate solids in this M/P range are of low solubility when chill cast, but generally devitrify when slow cooled and become more soluble. This behavior indicates a need to rely on container and environment rather than intrinsic insolubility, if this type phosphate solid were used as the final storage form of high level wastes. Of the two criteria used, it appears that drip temperature would be the one first applied when considering whether or not a given waste could be converted to a suitable phosphate solid. The results indicated the possibility of designing a plan for collecting the information that would permit prediction of the properties of a wide range of waste compositions when converted to phosphate solids. Even in the relatively limited range of variation in composition of the waste that might be turned out by a Purex process, it was found that the components interact on each other to such an extent that generalizations such as "sodium increase always results in a solubility increase," are not valid. It was demonstrated, however, that a properly designed experimental plan would allow determination of the overall effect of these interactions to the extent that predictions of the direction to look for the desired properties is valid, as well as approximation of the magnitude of these properties. The quadratic equations used to describe the system seems to follow the general behavior, but are probably too low an order to follow some of the perturbations. Intuitively, it seems that one would have difficulty finding equations that would describe a general system in which there were eutectics and compound formation such as appear to be the case in the range of composition examined. (auth)

23245 (LF-38, pp 92-100) THE PRODUCTION OF INSOLUBLE AEROSOLS OF FUSED CLAY CONTAMINATED WITH ^{91}Y, ^{137}Cs, AND ^{144}Ce. (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.).

In experiments to study the effects of inhalation of insoluble aerosols of fission-product radionuclides, characterization and understanding is simplified through the use of a basic vector (or carrier) aerosol to which the radionuclide of interest was added. A method was developed for producing insoluble aerosols of fused montmorillonite clay particles in the respirable size range into which a fission-product nuclide was entrapped. This method involved the following basic steps: clay preparation; nuclide ion exchange; aerosolization and fusion into smooth spheres; collection and resuspension; and aerosolization for the inhalation experiment. Some of the exchangeable clay ions are replaced by ions of the radionuclide of interest. The exchange levels obtainable were 2 Ci ^{137}Cs/gm clay, 6 Ci ^{144}Ce/gm clay, and 6 Ci ^{91}Y/gm clay. For suspension concentration of 8.0 mg/ml, the aerosol

produced had a particle size distribution that was log-normal with a count median diameter of 1.5 μ and a geometric standard deviation of 1.6 after passing through a 1150°C heat column. (auth)

23246 (LF-38, pp 101-2) USE OF AN ULTRASONIC GENERATOR FOR PRODUCING RADIOACTIVE AEROSOLS. (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.).

The use of an ultrasonic aerosol generator to aerosolize clay suspensions contaminated with radionuclides for subsequent fusing of the clay particles is described. Output and size distribution of the aerosol droplets and the resultant dry aerosol were determined. Flow rates for use in an experimental setup were investigated. It was determined that the use of ultrasonic aerosol generators to create insoluble and soluble respirable aerosols for toxicology studies of radionuclides offers several advantages over standard compressed-air nebulizers. (auth)

23247 (EURFNR-385) DOSE RATE OF REPROCESSED Na-1 BREEDER FUEL. Zimmermann, H. (Kernforschungszentrum, Karlsruhe (West Germany)). Translation of report KFK-603. 18p. Dep. CFSTI.

Work Performed under United States-Euratom Fast Reactor Exchange Program.

The activity of reprocessed Na-1 breeder fuel is calculated. Fuel from the more strongly enriched core zone 2 is considered as being less favorable. The activity consists of: gamma activity of fission products and plutonium isotopes as well as their successors; and the neutron activity of plutonium. It is dependent on the processing method. Joint reprocessing of core and blanket material is better because it gives lower activities than separate core processing. Fission-product activity, for instance, is reduced ~30% by joint processing. The decontamination factor should be more than 10^6, but certainly need not be more than 10^7. Shielding is provided by iron and paraffin. The material thickness needed depends on the fuel processing method, quantity and thickness. (auth)

23248 PROBLEMS IN THE DISPOSAL OF RADIOACTIVE WASTE IN GERMANY. Holtzem, H.; Schwibach, J. Atomwirt., Atomtech., 12: 413-17(Aug.-Sept. 1967). (In German).

Research on the final disposal of radioactive waste in the Federal Republic of Germany is described. As early as 1959 it was recommended that radioactive waste be stored in deep underground geologic formations. It was proposed that an artificial cavern be constructed in one of the more than 200 salt deposits of North West Germany for this purpose. A salt mine at Asse was acquired for the research and development of processes for the final storage of radioactive waste in salt deposits. Further research with international collaboration was concerned with the sinking of radioactive waste in the sea. Research has established the first prerequisites for the final disposal of waste of low to medium activity. The trial storage of 1700 barrels each with a capacity for 200 l of radioactive waste was started in the Asse salt mine. Problems of waste disposal in Germany are shifting to the final storage of highly active waste from future nuclear energy production. Investigations in this area are also in progress at the Asse salt mine. Studies of the long term safety of final storage and of the radiation protection technical requirements must however still be supplemented by the development of techniques for the consolidation of highly active waste. Studies so far justify the assumption that final disposal can be safely carried out by the methods of deep storage even in the densely populated German Federal Republic. (auth)

23249 TRANSPORTATION OF RADIOACTIVE MATERIALS. Blackburn, R. W. (Atomic Energy Control Board, Ottawa). 53p. of International Conference and Exhibition on a World Review of Nuclear Reactors and Radioisotopes, Montreal, Quebec, Canada, May 28-31, 1967. Toronto, Canadian Nuclear Association, 1967. (CONF-670522-11; 67-CNA-412).

Radioactive materials transport regulations which are internationally uniform for all modes of transport are being adopted by most countries including Canada. The basis for, application of, and effects on transport economics of these uniform regulations are discussed. (auth)

23250 DISCHARGE OF RADIOACTIVE WASTE WATERS TO PUBLIC WATERS. Neuhaus, G. M. Gas-Wasserfach., 106: 1035-9(1965).

The discharge of radioactive waste waters to surface waters is discussed and details are given of the difficulties and problems which arise when methods of treatment are inadequate and fail to reach the standard required by the maximal permissible concentration. (auth)

23251 RADIOACTIVE PACKAGE AND CONTAINER THEREFOR. Bruno, Gerald A.; Haney, Thomas A.; Numerof, Paul; Reinhardt, Karl (to E. R. Squibb and Sons, Inc.). U. S. Patent 3,369,121. Apr. 6, 1966.

A device for containing a column of elutable radioactive material is described. The device comprises a hollow body, in which the column of radioactive material is contained, closed at its two ends by pierceable closures, preferably made from resilient material. In this manner a closed system is achieved which can be sterilized and remains sterile in use. The device is preferably shipped in a shielding container having a removable closure. The removable closure and the bottom of the container are both apertured so that access can be had to the interior without removing the closure. By use of a closed system consisting of a hypodermic syringe containing the eluting solution, a sterile system for eluting the column and recovering the eluate containing the desired radioactive material is achieved. The preferred radioactive material contains the element ^{99}Mo yielding radioactive technetium as the eluted radioactive material. (Offic. Gaz.)

Vacuum Engineering

23252 CHARACTERISTICS OF AN ULTRAHIGH VACUUM CHAMBER. Tominaga, G. (Tokyo Univ.); Hirao, K.; Ito, T.; Hayashi, C. Vide, No. 132, 355-60(Nov.-Dec.1967). (In French).

The chamber is 2000 mm dia × 3000 mm in length and is designed for simulation of plasma in outer space. Made of nonmagnetic materials with necessary processing technique the chamber is highly nonmagnetic. A Helmholz coil is used to produce a homogeneous field in the space for the experiment. Two 36 in. oil diffusion pumps, a titanium sublimation pump, and a small sputter-ion pump are provided with a specially designed 54 in. UHV valve. Gas analysis by using a quadrupole revealed composition of gases and vapors during the evacuation, in build up, and effect of nitrogen filling to 1 atm pressure. End total pressure is 10^{-9} torr where valve will be closed and specified gas for plasma study will be filled to some high vacuum region for hours of experimentation. A wide range scanning probe mechanism is also used. (auth)

23253 CONSTRUCTION OF AN ALL-METAL APPARATUS TO STUDY THE SORPTIVE PROPERTIES OF METALLIC FILMS. Czarycki, W. (Institut d'Electronique Industrielle, Varsovie, Poland). Vide, No. 132, 351-4(Nov.-Dec. 1967). (In French).

The all-metal apparatus for the examination of gas sorption by metallic films in ultrahigh vacuum is described. A special kind of evaporator has been made and used which allows for continuous metal evaporation at a controlled rate. The curve of sticking probability vs coverage for adsorption of nitrogen by titanium films and results of surface potential change measurements made by the retarding field method are given. (auth)

23254 HYDROGEN PUMPING IN ULTRAHIGH VACUUM BY MEANS OF A SPUTTER-ION PUMP AND A NONEVAPORABLE GETTER PUMP. Della Porta, P.; Pisani, C. Vide, No. 132, 331-5(Nov.-Dec. 1967). (In French).

Hydrogen has been found to be the dominant gas in the residual atmosphere of an UHV metal system pumped by means of a sputter-ion pump and a nonevaporable getter pump. Measurements of pumping speed for hydrogen have been carried out at the lowest pressures (1.10^{-10} torr) by means of a rate of rise technique. It appeared that chemical pumping of hydrogen by the sputter-ion pump does not occur at an appreciable rate in typical UHV situations. (auth)

23255 ON THE PROPERTIES OF TITANIUM PUMPS DEVELOPED IN POLAND. Kiliszek, C. R. (Institut d'Electronique Industrielle, Varsovie, Poland). Vide, No. 132, 326-30(Nov.-Dec.(1967). (In French).

Results of research work on ion sorption pumps with cold and hot cathodes with pumping speeds for air from 1 to 100 l/sec, and limit pressure 10^{-10} torr are described. Application of sputter-ion pumps to direct pressure measurements and to the leak detection in vacuum systems also is given. (auth)

23256 STUDY OF THE DEGASSING OF MATERIALS AT VERY LOW PRESSURES. Thibault, J. J.; Roussel, J.; Jourdan, M. (Centre d'Etudes Cryogeniques, Sassenage, France). Vide, No. 132, 309-19(Nov.-Dec. 1967). (In French).

Experiments were conducted in order to measure the outgassing rates of materials in the ultrahigh vacuum range. The outgassing of stainless steel, copper and copper alloys, blackened copper, in the 10^{-7} to 10^{-10} torr range for pumping times up to 200 hr were studied. The measuring method used was the Oatley method. The data obtained are discussed using Langmuir's adsorption theory. (auth)

23257 CONDENSATION PUMPING OF HYDROGEN AND DEUTERIUM ON TO LIQUID-HELIUM-COOLED SURFACES.

Chubb, J. N.; Gowland, L.; Pollard, I. E. (United Kingdom Atomic Energy Authority, Abingdon, Eng.). J. Phys., D, 1: 361-70(Mar. 1968).

The condensation of hydrogen and deuterium on to liquid-helium-cooled surfaces is being studied for high-efficiency contamination-free pumping applications in plasma physics experiments. The experimental studies have shown that the sticking coefficient of hydrogen and deuterium at room temperature increases during initial coverage of a liquid-helium-cooled condensing surface from around 0.5 at about 10^{13} molecules cm^{-2} to between 0.7 and 0.95 at 10^{16} molecules cm^{-2}, and then remains essentially independent of further coverage. The sticking coefficient tends to increase with increasing gas incidence rate, but is only susceptible to surface temperature at the higher end of the range 2.1 to 3.7°K for very low gas inflow rates. During initial coverage of the condensing surface the desorption rate of gas molecules increases with surface coverage and reaches a steady value for coverages of about 3×10^{16} molecules cm^{-2}. This desorption rate does not decrease as rapidly with surface temperature as expected from published hydrogen and deuterium vapor-pressure curves. Experiments show that this is due to thermal-radiation desorption effects. The application of condensation pumping in practice to maintain gas densities below about 5×10^{9} molecules cm^{-3} (about 10 ntorr) thus requires some restriction of the thermal-radiation loading at the condensing surface. (auth)

23258 PRECISION MASK CHANGER FOR ULTRAHIGH VACUUM SYSTEMS. Seitchik, J. A.; Stein, B. F.; Goldberg, N. (Sperry Rand Corp., Philadelphia). Rev. Sci. Instrum., 39: 469-71(Apr. 1968).

A precision mask changer has been fabricated which uses a novel alignment technique to obtain precise registration between successive evaporations onto heated substrates in ultrahigh vacuum. A basic feature is the manipulation of the substrate while it is under vacuum and at the desired temperature. The registration process is observed by means of a split field microscope with objectives which can be individually focused on two areas of the substrate. Patterns have been registered to better than 5μ with the substrate at temperatures up to 200°C. In all cases the chamber pressure was 2×10^{-10} torr. (auth)

INSTRUMENTATION

Radiation Detection Instruments

Refer to abstract 22952.

General Detectors and Monitors

Refer also to abstracts 23203, 23505, 24068, 24821, and 25141.

23259 (BNWL-SA-1516) BACKGROUND REDUCTIONS OBTAINED WITH SODIUM IODIDE DETECTORS BY USING MASSIVE COSMIC-RAY SHIELDING. Kaye, J. H.; Brauer, F. P.; Connally, R. E.; Rieck, H. G. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Mar. 1968. Contract AT(45-1)-1830. 17p. DTIE.

A counting facility has been established 360-feet below the top of Grand Coulee Dam to investigate the effects of massive concrete and water cosmic-ray shielding on gamma detector backgrounds. Curves are presented which show that backgrounds at this facility are greatly reduced compared with surface values. A sodium iodide detector placed in an 8-inch-thick lead cave at Grand Coulee Dam has in fact a lower background than is obtainable at Richland (surface) by surrounding the detector with a 30-inch plastic scintillator anticoincidence detector and lead shielding. Both mercury and special lead shielding have been explored as a means of further reducing the background, yielding significant improvement at low energies. Detectors employing NaI(Tl) anticoincidence shielding have been tested inside 4-inches of mercury shielding and 8-inches of lead. Gamma-gamma coincidence detectors have also been evaluated. The facility has proven extremely useful for determining sources of background in detector components so that improved systems may be designed. (auth)

23260 (CEA-Bib-102) LES DETECTEURS A LOCALISATION POUR PARTICULES CHARGEES. (Position-Sensitive Detectors for Charged Particles). Helleboid, Jean-Marie (Commissariat a l,Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Feb. 1968. 25p. (In French). Dep.

Thesis.

In this report, we describe the possibilities of using position-sensitive detectors for charged particles. The circuits associated with several detectors forming a position-sensitive set of detectors are examined. The principle of position-sensitive detectors is reviewed, and the performances as well as the limits of actual realizations are discussed. (auth)

23261 (CEA-R-3241) ETUDE DES PROBLEMES POSES PAR L'UTILISATION DES DETECTEURS DE NEUTRONS THERMIQUES EN REGIME IMPULSIONNEL. APPLICATION A LA REALISATION D'UN TRANSFEROMETRE NUMERIQUE. (Study of the Problems Arising from the Use of Thermal Neutron Detectors in a Pulsed Regime. Application to the Development of a Digital Transferometer). Le Tilly, Yves (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Dec. 1967. 77p. (In French). Dep.

Thesis. Submitted to University of Paris, Orsay, France.

The instantaneous value of the counting rate of the pulses given by a fission detector settled in a reactor follows the neutron flux, but it is shown that the counter adds a white noise to the measured signal. This report deals with some possibilities of on-line numerical handling afforded by this kind of signal. The influence of an N-numerical divider is considered, and it is shown that, acting like a quantifier, it adds to the signal a white noise with the power $N^2/12$. One studies afterwards the principle of a digital filter aimed to Fourier analyse the signal. The realization of this device is described. It can be used in transfer function measurements of frequencies below 125 kHz. Some examples of experiments performed with this apparatus are presented. The design, according to the same principle, of a power spectral density analyser in the frequency range 0.01 – 10,000 Hz for random signal of the same kind is discussed. (auth)

23262 (CEA-R-3350) LE TRITIUM: MOYENS DE DETECTION ET DE PROTECTION. (Tritium: Means of Detection and of Protection). Sutra-Fourcade, Yves (Commissariat a l'Energie Atomique, Chusclan (France). Centre de Production de Plutonium de Marcoule). Dec. 1967. 104p. (In French). Dep.

An attempt to correlate present data concerning tritium, especially from the health physics points of view, is presented. The various detection and measurement methods are reviewed in turn: measurement of tritium in the atmosphere, in liquids, and on surfaces. The operation of various types of apparatus is analyzed and the sensitivity limits deduced from laboratory tests are given. Other sections are devoted to the means of protection which can be used against inhalation of tritium (ventilation, protective clothing) and to calculations of the changes in atmospheric pollution in a given place and of the time spent in a contaminated zone. The last part deals with the decontamination of equipment contaminated with tritium. (auth)

23263 (CEA-R-3378) REALISATION ET MISE AU POINT D'UN TELESCOPE A SEMI-CONDUCTEURS ET A FAIBLE BRUIT-DE-FOND POUR L'ETUDE DES REACTIONS NEUTRONS-PARTICULES CHARGEES. (Development of a Semiconductor Telescope with a Low Background for the Study of Charged Particles from Neutron Reactions). Helleboid, Jean-Marie (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Dec. 1967. 148p. (In French). Dep.

Thesis. Submitted to Univ. of Grenoble, France.

A ΔE-E counter telescope for charged particles (p, d, t) produced in reactions with neutrons has been constructed. The semiconductor counter telescope method allows the investigations of two and three-body reactions $^6Li(n,p)$, D(n,np)n induced by 14-MeV neutrons. By using a coincidence of associated alpha particle pulses with those (ΔE,E) in the telescope, the background is considerably reduced for all angles outside the coincidence cone, i.e., larger than 15°. For forward angles, the same telescope (ΔE_2,E) plus a thin semiconductor (ΔE_1) allows keeping a low background. The multiparameter analyzing method (ΔE_1, $\Delta E2$, E) from the experimental range-energy data gives a linearity, an efficiency, and an identifying power which are satisfactory. The identification is performed by deferred time on an IBM 7 044 computer. (auth)

23264 (CEA-R-3419) CONTRIBUTION A LA FABRICATION DE DETECTEURS A SEMI-CONDUCTEURS AU SILICIUM. (Contribution to the Manufacture of Silicon Semiconductor Detectors). Sandon, Michel (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Dec. 1967. 77p. (In French). Dep.

Thesis. Submitted to University of Grenoble, France.

Production methods used for making silicon semi-conductor detectors at the Nuclear Physics Laboratory in Grenoble are described. Detectors are of two types, either the lithium-compensated p – i – n type up to 3.5 mm thick, or the surface barrier type from 2 mm down to 10μ thick. The research into the surface barrier type concerned essentially the resolving power of the chemical contact obtained by Be evaporation (or Ni deposit), after a chemical attack (type C.P.I.) which is thickness-controlled and which gives a low surface current and a satisfactory flatness. The resolving power obtained (α 8.78 MeV, T ≈ –20°C) is of the order of 20 keV for thick detectors (surface barrier) and ≈50 keV for very thin detectors (10μ), and for p – i – n type detectors (≈50 keV at T + 20°C). (auth)

23265 (INR-P-867/IA/E) TIME SPREADS OF PULSES GENERATED BY β PARTICLES IN SILICON DRIFTED DETECTORS. Moszynski, M.; Kurcewicz, W.; Przyborski, W. (Institute of Nuclear Research, Warsaw (Poland)). 1967. 35p. Dep.

Results of the study of the time spreads of pulses from the silicon drifted detectors irradiated by 976 keV ^{207}Bi beta particles at their positive electrode side are presented. A number of 0.8 – 2.4 mm thick detectors were tested at the room temperature and the liquid nitrogen temperature. Two components of the time spreads have been found to exist; one of them being proportional to the detector pulse rise time and inversely proportional to the reduced average range of beta particles, and another independent of these quantities but characteristic of the individual detector. Initial risetimes of the pulses were determined. The results are in disagreement with predictions of the available theory of charge collection in the detectors. (auth)

23266 (JEN-183-DF/1-56) DETECCION DE RADIACIONES NUCLEARES. (Detection of Nuclear Radiation). Tanarro, A. (Junta de Energia Nuclear, Madrid (Spain)). 1967. 108p. (In Spanish). Dep.

A summary of the lectures about the ordinary detectors of nuclear radiations explained by the author in the courses of nuclear engineering held at the J.E.N. up to the date of publication is given. Those lectures are considered to be a necessary introduction to "Nuclear Instrumentation" and "Applied Electronics to Nuclear Engineering" so it has been intended to underline those characteristics of radiation detectors that must be taken into consideration in choosing or designing the electronic equipment associated to them in order to take advantage of each detector possibility. (auth)

23267 (SC-M-68-245) A NEW FAMILY OF TRITIUM MONITORING EQUIPMENT OFFERING COMPLETE PERSONNEL

PROTECTION. (Sandia Corp., Albuquerque, N. Mex.). Mar. 1968. Contract AT(29-1)-789. 10p. Dep. CFSTI.

Technical specifications are presented for a complete line of tritium monitoring equipment. The equipment includes T446–Tritium Alarm Monitor, T447–Tritium Monitor Display Indicator, T449–Radiological Urinalysis Kit, and S152–Tritium Monitoring Console. (B.G.D.)

23268 (UJV-1885) INTEGRATION OF FAST NEUTRON FLUXES BY MEANS OF THE ACTIVITY OF ^{54}Mn PRODUCED IN IRRADIATED STEEL SAMPLES. Kadlec, V.; Vitek, M. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). Aug. 1967. 29p. Dep.

The use of $^{54}Fe(n,p)^{54}Mn$ reaction as an activation integrator of fast neutron fluxes is discussed. Arguments for a quick and accurate evaluation method of an integrator by means of a semiconductor detector with a resolution better than 1% are given and examples shown. The given method makes it possible to evaluate the integrated fast neutron fluxes directly by means of irradiated steel samples with no special detector of pure iron. Hence, the absorbed dose at any point of the irradiated specimen can be estimated. An additional advantage of this method is that there is no need of any chemical separation of ^{54}Mn from irradiated detectors and no costly iron enriched in ^{54}Fe is required. Most frequently quoted values of $\sigma_0 = 53$ mb and $T_{\frac{1}{2}} = 314$ d are used throughout this paper. (auth)

23269 INVESTIGATIONS ON THE LIGHT DECOUPLING FROM SCINTILLATING CRYSTALS. Greupner, H.; Kerkow, H.; Schwabe, St. (Humboldt Univ., Berlin). Kernenergie, 11: 10-14(Jan. 1968). (In German).

The calculation of the fraction of luminescent light to be decoupled from conic and cylindrical scintillators is discussed. The geometric-optical calculations are experimentally checked and verified for some arrangements. Comparison between experiments and calculation shows among other facts that a greater fraction of the produced light can always be decoupled from the conic scintillator than from the cylindric one. (auth)

23270 NECESSARY AND SUFFICIENT RADIATION PROTECTION MEASUREMENTS IN WORKS UTILIZING SOURCES OF IONIZING RADIATION. Jaeckel, P (Staatliche Zentrale fuer Strahlenschutz, Berlin). Isotopenpraxis, 3: 491-4(Dec. 1967). (In German).

The type and extent of radiation protection measurements carried out depend on the type of operation with the radiation sources and the source intensity. The characteristics of sealed radiation sources, open radioactive materials, and installations emitting ionizing radiation are discussed. The devices used for monitoring including individual dosimeters, dose output meters, contamination control devices, and air monitoring devices are discussed. (J.S.R.)

23271 X-RAY LUMINESCENCE DEPENDENCE OF NaCl PHOSPHORS ON RADIATION TIME. Ivanii, G. M. (Dnepropetrovsk State Univ., USSR). Ukr. Fiz. Zh., 12: 2063-4(Dec. 1967). (In Russian).

The time dependence of x-ray luminescence intensity on the length of irradiation for NaCl phosphors was investigated for various irradiation temperatures and intensities of 12 kV and 2 mA to 60 kV and 12 mA. The crystalline and powdered phosphors from both natural and artificial NaCl, were activated with Ni, Ag, and Cu by thermoelectric diffusion and by heating to 600°C. In both cases the luminescence of the phosphors depended in the same way on the irradiation time. Pure crystals were found to have a constant value of B, the x-ray luminescence intensity, for various irradiation conditions. In all other cases, B decreased with time. For powdered phosphors the drop in intensity in 60 minutes was found to be 50% or more as given by the formula: $B = B_m(1 + Bt)^{-n}$, whereby B_m is the maximum value of x-ray luminescence and t is the time. For many instances it was found that the coefficient $B = 7 \times 10^{-3}$ sec and $n = 0.55$. (TTT)

23272 SCINTILLATION RESPONSE OF PRESSED SILICON-TREATED ALKALI HALIDE POWDERS. Galvin, J. M.; Kereiakes, J. G. (Univ. of Cincinnati). Health Phys., 14: 376-7(Apr. 1968).

The pressure technique for the fabrication of scintillation crystals is described. Cesium iodide, which has physical properties well suited for this procedure, was used with thallium as the activator. The pellet pulse height response (for the 0.082 MeV peak of barium-133) was checked by periodic coupling to a 3 in. RCA photomultiplier tube. The pulse height was found to increase gradually to a maximum value in approximately 1 week. The increased pulse height was probably due to the silicone fluid providing a more homogeneous light index of refraction throughout the crystal, although no marked visible change was noticed in the CsI pellet appearance. Other pressed alkali halide pellets, such as lithium fluoride, did show a marked change in physical appearance following silicone fluid treatment. The effect of thallium content on pulse height is shown graphically and corresponds to findings for a single grown crystal. The effect of crystal thickness on pulse height for constant 0.1% (by weight) thallium activation is also shown. The technique described is also applicable for the fabrication of scintillation crystals containing various activators. (auth)

23273 ON THE USE OF THE $(\beta^+\gamma^+)$ COINCIDENCE METHOD IN INVESTIGATIONS ON POSITRON EMITTING NUCLIDES. Vatai, E. Acta Phys. Acad. Sci. Hung., 23: 381-92(1967). (In Russian).

A detailed analysis of possibilities of the $(\beta^+\gamma)$ coincidence method for determination of positron detector counting efficiency (S_{β^+}), and accordingly possibilities for positron activity determinations of sources are given. Such analysis is necessary, because the annihilation quanta are emitted from a finite volume, and the equations for a point source in this case are not valid. Ways to account or reduce the effect of the annihilation spatial distribution are by numerical integration and by increasing the distance between the source and detector of annihilation quanta. The use of proper measurement parameters make possible the reduction of the effect of spatial distribution of annihilation on the accuracy of counting efficiency (S_{β^+}) determination to 10^{-3} or less. (auth)

23274 DETERMINATION OF THE COUNTING EFFICIENCY IN CASES OF RADIATION MEASUREMENT OF THE WIDE-SPREAD SOLID ALPHA SOURCES. Toth, A. (Mev Health Service, Pecs, Hungary). Acta Phys. Acad. Sci. Hung., 23: 349-61(1967).

The dependence of alpha counting efficiency on energy, source thickness and instrument constant are described in a comprehensive manner. The efficiency value calculated theoretically is also supported by experiment. (auth)

23275 INSTRUMENTS. Nucl. News, 11: 41-2(Jan. 1968).

Industrial sales and research on reactor control instruments and radiation detection and monitoring instruments are reviewed. Major companies which manufacture radiation detection and monitoring instruments are listed. (W.H.K.)

23276 NUCLEAR INSTRUMENTATION. NO. 31. Instrum. Nucl. (Paris), No. 31, 1-73(Dec. 1967). (In French).

The design and specifications of detectors, amplifiers and preamplifiers, standardized functional elements, and radioprotection devices recently developed by the CEA are reported. Topics discussed include a proportional counter for low-energy x-ray spectrometry aboard space vehicles, center blocks with low selfmovement or guaranteed stability, high resolution charge preamplifier of the PSC 20 type, rapid forming gate for modular generators of the FIT 40 type, new multichannel analyzers, complementary material for multiparameter analysis chains, fast monochannel amplitude selector of the BSA 10 type, γ spectrometry device, control device for U losses in irradiated claddings, fast contamination monitor, U detector monitor, tritium atmospheric activity counter, application of logical circuits to the improvement of some commonly used devices, and centers of analog calculation of the CEA. (J.S.R.)

23277 Au–Si SURFACE BARRIER SEMICONDUCTOR NUCLEAR PARTICLE DETECTORS. Lee, Chul Chu; Ko, Youn Kyu; Kim, Do Kyong; Choi, Sun Pil (Yonsei Univ., Seoul). New Phys. (Korea), 7: 75-80(Dec. 1967).

Au–Si surface barrier semiconductor particle detectors were fabricated with n-type silicon single crystal of 1000 ohm-cm resistivity on which gold was coated in vacuum. Using these detectors with 25mm^2 of effective area, 0.22 percent of resolution at fwhm was obtained for 5.477-MeV alpha particles from ^{241}Am. The fabrication procedures and several characteristics of the semiconductor particle detectors are reported.

23278 INVESTIGATION OF SINGLE-CRYSTAL, HIGH-RESISTIVITY CADMIUM TELLURIDE AS A GAMMA-RAY SPECTROMETER. Baily, N. A.; Andres, R. J. (Hughes Research Labs., Malibu, Calif.). Nucl. Appl., 4: 337-46(May, 1968).

High-purity, single-crystal cadmium telluride has been investigated from the viewpoint of its possible use for gamma-ray detection and spectroscopy. The width of its band gap makes the material an attractive possibility for room-temperature operation. At present, its performance is apparently limited by carrier trapping. Although surface barriers can be established on both p- and n-type materials, diffused junctions have not yet been obtained.

Ohmic contacts have been formed on various materials under specific conditions. However, the general problem of establishing such contacts is still unsolved. In a limited number of crystals, magnesium or boron ions were found to drift within the crystal under the action of an electric field and thereby establish a compensated region. The surface barrier devices fabricated responded to both alpha particles and gamma rays. In some materials, pulses corresponding to the full particle energy were observed. The best resolution (for alpha particles) obtained as measured by the full width at half maximum was ~25%. Noise levels even at elevated temperatures were generally below 20 keV. The main problems with presently available materials appear to be a lack of crystal uniformity and structural integrity. (auth)

23279 REDUCTION OF COSMIC RAY BACKGROUND IN NaI CRYSTAL WITH A CHERENKOV ANTICOINCIDENCE SHIELD. Del Bianco, W.; Lemire, F. (Univ. of Montreal). Nucl. Instrum. Methods, 61: 229-31(May 1968).

The cosmic ray background in a 5'' dia. × 6'' long NaI(Tl) crystal was reduced by enclosing it in a Cherenkov anticoincidence shield surrounded by a 4'' thick layer of lead. The reduction factor was 26 between 10 and 30 MeV and 61 between 15 and 97 MeV. (auth)

23280 DEPENDENCE OF THE DEAD TIME AND RECOVERY CURVE OF THE PULSE HEIGHT OF A GEIGER–MUELLER COUNTER. Glaeser, M. (Paedagogische Hochschule, Potsdam, Ger.). Nucl. Instrum. Methods, 61: 217-20(May 1968). (In German).

The assumptions made in a correction theory developed by Kramers for the counting rate of Geiger-Mueller counters were tested experimentally. The results obtained for Vakutronik-GM counters (containing organic quenching vapor) require the introduction of a new quantity for the calculation of the correction-factors, the minimal dead-time. A function is given for the envelope of the peaks of the pulses, which appear during the recovery-period. (auth)

23281 TIME SPREADS OF PULSES GENERATED BY BETA-PARTICLES IN SILICON DRIFTED DETECTORS. Moszynski, M.; Kurcewicz, W.; Przyborski, W. (Inst. of Nuclear Research, Swierk, Poland). Nucl. Instrum. Methods, 61: 173-80(May 1968).

Results of a study of time spreads of pulses from silicon drifted detectors, irradiated by 976 keV (^{207}Bi) electrons at their positive electrode side, are presented. A number of 0.8–2.4 mm thick detectors were tested at room temperature and at liquid nitrogen temperature. Two components of the time spreads have been found to exist; one of them being proportional to the detector pulse rise time and inversely proportional to the reduced average range of the beta particles, and the other one independent on these quantities, however, characteristic for the individual detector. Initial risetimes of the pulses (up to 20% of the total amplitude) were determined. The results are in disagreement with the predictions of the available approximate theory of charge collection in detectors. (auth)

23282 METHOD OF MEASURING ALPHA–GAMMA ANGULAR CORRELATION USING CATHODE PULSES IN A GRIDDED IONIZATION CHAMBER. Doke, T. (Tokyo Univ.); Miyajima, M. Nucl. Instrum. Methods, 61: 181-8(May 1968).

An improved method of measuring the alpha-gamma angular correlation is proposed. The apparatus consists of a gridded ionization chamber and a NaI scintillation counter. In a gridded chamber, generally, the cathode pulse yields information on the emission angle of an alpha particle, while the collector pulse gives information on its energy. Accordingly, the alpha-gamma angular correlation of mixed alpha sources, in which some isotopes emitting alpha particles of different energies and subsequent gamma rays of almost the same energy are included, can be easily measured from the pulse height distribution of the cathode pulses coincident with the scintillation pulses and the collector pulses in the desired energy intervals, respectively. As examples, the angular correlation for two decay series in the daughter products of ThB, which is 1. ThC′*(γ)ThC′(α)ThD and 2. ThC(α)ThC′′*(4+)(γ)ThC′′(5+) were measured. The results are in good agreement with theoretical prediction and those obtained by other workers. (auth)

23283 LOW LEVEL GAMMA-COUNTING APPARATUS. Stenberg, A.; Olsson, I. U. (Inst. of Physics, Uppsala). Nucl. Instrum. Methods, 61: 125-33(May 1968).

An apparatus for low level gamma measurements using two 3'' × 3'' NaI(Tl) detectors is described. The shield is built of about 10 tons of lead and 160 kg of paraffin and boric acid mixture. Forty-five G–M counters are used as an anticoincidence screen. Background spectra above 40 keV are shown. The total background above 100 keV in one detector inside the shield is 203 cpm. When using the Geiger anticoincidence arrangement this figure is reduced to 100 cpm. Twelve cpm of this remaining activity is produced by the cosmic ray meson part, 19 cpm by the cosmic ray neutron part, 26 cpm by airborne radon, 9 cpm by ^{40}K (mainly in the glass envelope of the photomultiplier) and 33 cpm by nonspecified activities in and outside of the shield and in the detector itself. Advantages and disadvantages of cadmium as lining material are discussed. (auth)

23284 SEMICONDUCTOR DETECTORS FOR IONIZING RADIATIONS AND THEIR CHARACTERISTICS. Varyushchenko, S. B.; Kulichenko, L. N. Izmer. Tekh., No. 1, 91-2(Jan. 1968). (In Russian).

Semiconductor detectors based on electron-hole transitions, which have an excellent energy resolution and good selectivity, are considered very promising for special applications. Three types of detectors are used: 1. surface barrier-type instruments involving a layer depleted in n-p transitions; 2. diffusion detectors, in which the n-p transition is created by the diffusion of the n or p conductivity component in the semiconducting layer; and 3. the diffusion-drift type silicon detectors, possessing an n-i-p structure, with a Li-drifted layer representing the sensitive region. The operational characteristics of various detectors are tabulated. The germanium-based γ detectors include the lithium-drifted systems, and the radiation counters with an active region created by the compensation of the original electron conductivity by exposure to penetrating radiation and introduction of acceptors responsible for structural defects. (Review article). (TTT)

23285 CLINICAL USE OF WHOLE-BODY COUNTERS. Oliver, R.; Warner, G. T. (United Oxford Hospitals). Bio-Med. Eng., 2: 534-8(Dec. 1967).

Construction, design, and use of whole-body counters in clinical medicine are reviewed. One type of scanning, shadow-shield monitor which is described in detail, has a lower sensitivity than is obtainable with counters in a fully shielded room. It is, in general, limited to use with nuclides with γ emission above 0.5 MeV energy. The monitor, incorporating the shadow-shield principle, offers a design suitable for hospitals from both the point of view of apparatus expense and weight. The general design also offers the possibility of construction of a mobile counter. This instrument uses a very large (11-in.) crystal with wide-angle collimation, but the total weight is only 7 tons. As there is only one detector the patient must be counted both prone and supine. A further major advantage of the scanning system is that it provides extremely good uniformity of response with variation of distribution of activity within the body, which is essential in clinical investigations. (BBB)

23286 RESOLVING POWER OF A FINITE SIZED IONIZATION CHAMBER BY MEANS OF THE MODULATION TRANSFER FUNCTION. Hayami, Akimune (Osaka Univ.). Nippon Igaku Hoshasen Gakkai Zasshi, 27: 1173-8(Dec. 1967). (In Japanese).

The resolving power of a finite sized ionization chamber has been discussed by several workers, but the Modulation Transfer Function (MTF) has never been introduced into their analyses. The resolving power was determined by means of MTF. A finite sized ionization chamber was examined in air by theoretical calculations and basic experiments, leading to one dimensional MTF. The experimental results were in good agreement with those of calculations. It is found that the resolving power and the sharpness of a finite sized ionization chamber can be determined using this method. It might be interesting that there was spurious resolution observed probably because of the cylindrical shape of ionization chamber. This method appeared to merit for the determination of the true dose distribution, cutting off the experimental errors such as the influence of the diameter of cylindrical ionization chamber. (auth) (NSA of Japan)

23287 ACHIEVEMENTS AND STATUS OF SOVIET NUCLEAR PHOTOGRAPHY. Kartuzhanskii, A. L. Zh. Nauch. Prikl. Fotogr. Kinemotogr., 13: 57-69(Jan.–Feb. 1968). (In Russian).

A brief review is given on the development of nuclear emulsions and the methods used for their preparation. Improved methods for chemical photographic development and sensitometry in nuclear photography, particle interactions with microcrystals, photographic sensitivity for particles, and latent images formed by particle interactions are discussed. 119 references are included. (R.V.J.)

23288 MEASUREMENT OF NEUTRON SPECTRA BY THE TRANSMISSION METHOD. Navalkar, M. P.; Ramakrishna, D. V. S. (Bhabha Atomic Research Centre, Trombay, India). Nucl. Instrum. Methods, 61: 37-40(Apr. 15, 1968).

An experiment measuring the transmission through various thicknesses of silver in a beam of neutrons emerging from the CIRUS and APSARA reactors was undertaken. The experimental data were analyzed both for single and multiple collision phe-

nomena. It is seen that neglection of multiple scattering in the present experimental set-up gives rise to an error which is less compared to the error on the measured value of the temperature by single collision treatment. The emergent spectrum at CIRUS shows a temperature consistent with that obtained from a well thermalized reactor whereas in case of the swimming pool reactor APSARA, a temperature much higher than the physical temperature is obtained. However, this is consistent with the effective temperature of an equivalent homogenized reactor moderator with actual core parameters. (auth)

23289 MEASUREMENT OF THE THERMAL NEUTRON FLUX WITH FOILS. Ilberg, D.; Segal, Y. (Technion-Israel Inst. of Tech., Haifa). Nucl. Instrum. Methods, 61: 93-8(Apr. 15, 1968).

The influence of self-shielding, self-absorption and flux depression on the apparent beta and gamma activity of foils is calculated and measured. It is shown that the apparent activity does not always increase with increasing foil thickness and even decreases in certain cases. Different foil materials, various activating media, and counting techniques are studied. (auth)

23290 INTERNAL STANDARD WITH IDENTICAL SYSTEM PROPERTIES FOR DETERMINATION OF LIQUID SCINTILLATION COUNTING EFFICIENCY. Moghissi, A. A.; Carter, M. W. (Southeastern Radiological Health Lab., Montgomery, Ala.). Anal. Chem., 40: 812-14(Apr. 1968).

The internal standard with identical system properties (ISISP) method for determining scintillation counting efficiency is described. The method uses two sample aliquots that are identical in their chemical and quenching properties. In one aliquot a radionuclide is replaced by its stable isotope. The samples are then counted consecutively to minimize the effect of any instrumental drift. Comparative data for the ISISP and internal standard (IS) methods for tritium using various scintillation solutions and standards showed that accurate measurements using the ISISP method could be made even in the presence of strong quenchers, whereas, the conventional IS method was unreliable. A comparison of the two systems using various standards containing ^{14}C for different scintillators, quenchers, and degrees of quenching was made. Although the deviations in counting efficiency using the IS technique were not so large for ^{14}C as for tritium, the presence of quenchers adversely affected the accuracy of counting efficiency using the IS method, whereas, it had no appreciable effect using the ISISP method. It was concluded that the nature of quenching materials and the degree of quenching have no effect on the accurate determination of counting efficiency in the ISISP method, the only limitations being statistical considerations. (D.H.M.)

23291 PROPORTIONAL COUNTER RESOLUTION. Charles, M. W.; Cooke, B. A. (Univ. of Leicester, Eng.). Nucl. Instrum. Methods, 61: 31-6(Apr. 15, 1968).

The present state of the theory of proportional counter resolution is reviewed. In any attempt to achieve the ultimate resolution indicated by present theories it is shown that anode wire uniformity is a critical factor and that window effects are of little importance. Typical wire finish has been examined and improved wire has been used to obtain resolutions for a 90% argon, 10% methane gas mixture better than any previously published results in the 0.2 to 10 keV x-ray energy region. (auth)

23292 EVALUATION OF THE ALPHA COUNTING TECHNIQUE FOR DETERMINING 14-MeV NEUTRON YIELDS. Fewell, T. R. (Sandia Corp., Albuquerque, N. Mex.). Nucl. Instrum. Methods, 61: 61-71(Apr. 15, 1968).

A discourse on the principal problems associated with determining the neutron yield from the T(d,n)α reaction is attempted. Techniques are developed for calculating the number of neutrons produced in the target per α particle emitted into any solid angle. The equations are extended to handle unanalyzed deuteron beams. Geometry considerations, competing reactions and other problems are discussed. In order to determine the criteria for selecting an optimum design for the target assembly, an analytical treatment of the problems is performed. The optimum target design for most circumstances is identified and its accuracy calculated. The paper provides, in a form usable by people at the working level, all the information needed for determining neutron yields, the accuracy of the neutron yields, and the optimum system design for implementing the T(d,n)α reaction. (auth)

23293 CALIBRATION OF A SEMICONDUCTOR DETECTOR TELESCOPE FOR SPACE EXPERIMENTS. Lanzerotti, L. J. (Bell Telephone Labs, Inc., Murray Hill, N. J.). Nucl. Instrum. Methods, 61: 99-107(Apr. 15, 1968).

A description of the procedures and results of the electron and proton calibrations of two identical satellite experiments is reported. The experiments each consisted of a six element solid state detector telescope and were designed to investigate the particle flux and population in the earth's magnetosphere. (auth)

23294 EXPERIMENTAL DETERMINATION OF A CORRECTION IN THE $4\pi\beta$-γ COINCIDENCE MEASUREMENTS ON ACTIVATED GOLD FOILS. Kawada, Y.; Michikawa, T.; Yamashita, M. (Electrotechnical Lab., Tokyo). Nucl. Instrum. Methods, 61: 117-18(Apr. 15, 1968).

The correction for internal conversion and γ-sensitivity of the β-detector in the $4\pi\beta$-γ coincidence method of measuring activated gold foils was determined experimentally by the combination of $4\pi\beta$-γ and $2\pi\beta$-γ coincidence measurements. The method requires no information of the internal conversion coefficient and the inherent γ-sensitivity of the β-detector, and the results are obtained with an adequate accuracy. A comparison with the reported calculations is in good agreement. (auth)

23295 ABSOLUTE EFFICIENCY MEASUREMENTS OF ^{252}Cf ORGANIC PHOSPHORS FOR DETECTING 14.5- AND 2.7-MeV NEUTRONS. Love, T. A.; Santoro, R. T.; Peelle, R. W.; Hill, N. W. (Oak Ridge National Lab., Tenn.). Contract W-7405-eng-26. Rev. Sci. Instrum., 39: 541-7(Apr. 1968). (ORNL-P-3484).

The absolute efficiency of two NE-213 organic phosphors for detecting 14.5- and 2.7-MeV neutrons has been determined by the associated particle technique with the recoil particles from the $T(d,n)^4He$ and $D(d,n)^3He$ reactions. The output of the neutron detector was placed in coincidence with the helium recoil pulses and the efficiency of the detector was obtained as the ratio of the coincidence counts to the helium recoil counts. The scintillators were 12 cm in diameter and had thicknesses of 2.61 and 6.10 cm, and each was preceded by a 5-mm thick NE-102 plastic scintillator and followed by a 3.3-cm (average thickness) Lucite light pipe. The detection efficiency, for neutrons striking the central 25% of the detector area, was measured as a function of the bias level on a tunnel diode driven by the current pulse from dynode 14 of a 58AVP multiplier phototube and also as a function of a bias threshold on the total light output. The bias level was calibrated in terms of the pulse-height spectra resulting from the interactions in the phosphors of gamma rays of several energies. Comparisons were made between experimental efficiencies and those obtained from Monte Carlo calculations. For a threshold of 40° ± 5 keV electron total light equivalent, the agreement is within 7% for the smaller detector and 1.5% for the larger. (auth)

23296 PHOTOPEAK EFFICIENCY OF A WELL-TYPE SCINTILLATION DETECTOR. Hanson, W. G.; Sargent, B. W. (Queen's Univ., Kingston, Ont.). Rev. Sci. Instrum., 39: 529-31(Apr. 1968).

The detection and photopeak efficiencies of a NaI cylindrical crystal, 7.62 cm dia and 7.62 cm high, containing a 0.63 cm dia well, 4.13 cm deep, were experimentally determined for 0.51 MeV gamma radiation from ^{11}C positron annihilation. The pulse-height distribution measured with the source on top of the crystal was used with probability theory to obtain an approximate synthetic summed spectrum for the source in the well. This in turn was used to analyze the observed pulse-height distribution for the source in the well. The detection and photopeak efficiencies are 0.70 ± 0.02 and 0.49 ± 0.01, respectively, from which the photofraction is 0.70 ± 0.03. Agreement with calculated values is good. (auth)

23297 INTERNAL AMPLIFICATION α DETECTOR. Koyama, Masaki (Musashi Inst. of Tech., Kawasaki City, Japan). Rev. Sci. Instrum., 39: 611-12(Apr. 1968).

Internal pulse amplification in a silicon three-electrode surface-barrier detector for alpha particles is investigated. The dependence of response characteristics on bias voltage is discussed. (W.H.K.)

23298 AVERAGE NUMBER OF TRIGGERED COUNTERS IN AN EXPERIMENTAL ARRANGEMENT FOR RECORDING OF EXTENSIVE AIR SHOWERS ACCOMPANIED BY NUCLEAR-ACTIVE PARTICLES. Betev, Bot'o. Izv. Fiz. Inst. Aneb, Bulg. Akad. Nauk., 16: 5-10(1967). (In Bulgarian).

A theoretical determination was made of the average number of triggered counters in an experimental arrangement consisting of a detector of nuclear-active particles and k unshielded counters situated in a horizontal plane. The events recorded by these experimental conditions are identified as extensive air showers accompanied by nuclear-active particles. By an exponential law of density spectrum, the average number of the ignited counters depends only on the number of unshielded counters and on the exponent γ of the density spectrum. (auth)

23299 CERTAIN PROFILE FEATURES OF THE MODERATOR FOR REALIZING A COUNTING DEVICE OF FAST NEUTRONS AND OF A STANDARD SOURCE OF THERMAL NEU-

TRONS. Mishev, Iliya (CNEN, Rome). Izv. Fiz. Inst. Aneb, Bulg. Akad. Nauk., 16: 17-26(1967). (In Bulgarian).

Experimental investigations were made of the cube and of the cylinder with a view to their utilization as hollow moderators of a measurement system of fast neutrons with a proportional BF_3-counter. Both shapes provide point symmetry for the neutron detector and angular independence of the readings for distances $r \geq 80$ cm. For a distance of r = 22 cm, this angular dependence reaches 31% for both shapes. Compared with the sphere and cylinder, the maximum degree of sensitivity of measurement is provided by the cube, when the neutron flow drops perpendicular to its walls. A method has also been found of realizing a standard source of thermal neutrons with point symmetry in an angle 4π by using a standard source of fast neutrons placed in a hollow paraffin sphere with cover thickness of 7 cm. If R is the outer radius of the sphere and Q is the neutron yield of the source of fast neutrons, then for every distance r > R the thermal neutron flux will be $f = 5.10^{-3} Q/r^2$. (auth)

23300 NEW TYPE OF ELECTRONIC RECORDING SYSTEM FOR A STANDARD NEUTRON MONITOR. Akhababyan, Nash'n; Betev, Bot'o; Zlatarov, Vasil; Tsvetkov, Tsvetan. Izv. Fiz. Inst. Aneb, Bulg. Akad. Nauk., 16: 27-34(1967). (In Bulgarian).

An electronic recording system for a standard neutron monitor is described whose stability yields an error in counting smaller than the statistical error of the apparatus. This has been achieved on the basis of a new regime of feeding the neutron counters which makes it possible to set up the electric diagrams with the necessary parameters. The apparatus built in this manner has been installed in the Cosmic Station on the Moussala Peak and has been used, since 1964, for continuous recording of the intensity of the neutron component of cosmic rays. (auth)

23301 PORTABLE SCINTILLATION TYPE WEAK-BETA CONTAMINATION METER. Payer, K.; Vasvari, G. Meres Automat., 13: 367-9(1965). (In Hungarian).

A portable, transistorized contamination meter for measuring weak-beta and gamma radiation has been constructed. The detector consists of a plastic-scintillator connected with a Zeiss M 10 FS 25 photo-multiplier. The electronic part contains a highly stabilized high-voltage power supply, a wide-band amplifier, a pulse shaping stage and an integrating stage. The lowest detectable radioactive contamination is 3.10^{-4} $\mu Ci/cm^2$ for weak-beta and $1,5.10^{-4}$ $\mu Ci/cm^2$ for gamma radiation. (EAJ)

23302 QUANTUM THEORY OF PHOTODETECTOR CORRELATIONS. Paoli, Thomas Lee. Stanford, Calif., Stanford Univ., 150p.

Thesis.

Autocorrelation and cross correlation operators for the outputs of photodetectors illuminated by arbitrary radiation fields are studied in terms of quantum field theory. Emphasis is placed on evaluating contributions which originate in the nonzero commutators of the radiation field operators and on estimating the noise inherent in the measurement of cross correlation functions. This theory is applied to the high-resolution spectroscopy of thermal radiation by means of the cross correlation obtained with an intense, coherent background illumination. The quantum theory of photodetector correlations is discussed in terms of symmetrized correlation operators in the Heisenberg picture. Time dependent perturbation theory utilizing methods of scattering theory is used to obtain the lowest order contributions to the mean and variance of the correlation operators. A finite temperature photodetector is described in terms of the one-electron approximation of the band theory of crystalline solids. Properties of photocathodes pertinent to the evaluations are demonstrated by explicit calculation for a Sommerfeld metal. In contrast to previous discussions, contributions to the ensemble averages of the correlation operators, which originate in the quantum nature of the field, are shown to be exactly zero under reasonable assumptions about the physical properties of detectors. The expected signal/noise ratio in high-resolution spectroscopy with an intense coherent background is determined by the number of electrons emitted in a coherence time of the radiation when the detectors are slow and in a detector response time when the detectors are fast. The total time required for the high resolution determination of a line-shape with a high signal/noise ratio is prohibitively long even for bright stellar sources but not for laboratory sources. (Disser. Abstr.)

23303 EINFUEHRUNG IN DIE KERNTECHNIK. (Introduction to Nuclear Techniques). Adam, Hans. Munich, R. Oldenbourg Verlag, 1967. 454p.

An introduction to nuclear techniques, designed for students in engineering schools, is presented. The basic data on atomic structure, radioactivity, and interaction between nuclear radiation and matter are outlined. The principal detection devices for nuclear radiation are described. Nuclear techniques are then discussed in some detail. (J.S.R.)

23304 SEMICONDUCTOR DIODE WITH IMPROVED HIGH VOLTAGE CHARACTERISTIC AND METHOD OF PRODUCTION THEREOF. (to United States Atomic Energy Commission). British Patent 1,108,870. Apr. 3, 1968. Priority date Mar. 8, 1966, United States.

A thick semiconductor detector which operates at high voltage and is designed for detecting high-energy charged particles and x rays is described. The detector is designed to minimize surface current by utilizing the shelf structure. The fabrication and operation of the detector are discussed. (W.H.K.)

23305 IMPROVEMENTS IN OR RELATING TO LIQUID SCINTILLATOR CELLS. Loosemore, William Ronald; Leake, John Walgate (to United Kingdom Atomic Energy Authority). British Patent 1,107,404. Mar. 27, 1968. Filed May 25, 1964.

A liquid scintillator cell is designed so that for any orientation the gas bubble, necessarily included in the cell to allow for thermal expansion, does not touch the surface of the cell against which the photomultiplier tube rests. (W.H.K.)

23306 APPARATUS FOR SAMPLING AEROSOLS. Garnier, Andre (to Societe Siersatom). British Patent 1,109,777. Apr. 18, 1968. Priority date Apr. 8, 1966, France.

A personnel monitor for sampling aerosols contaminated by radioactive particles is described. This device is primarily intended for the use of persons working in hot cells or shielded caves and engaged in the handling of radioactive materials. (B.G.D.)

Nuclear Spectroscopic Instrumentation

Refer also to abstract 22945.

23307 (BNL-12332) A TOTAL ABSORPTION Ge(Li) GAMMA RAY SPECTROMETER. Kraner, H. W.; Chase, R. L. (Brookhaven National Lab., Upton, N. Y.). [1968]. 20p. (CONF-680207-4). Dep. CFSTI.

A configuration of a large Ge(Li) detector has been developed which suppresses single, local interactions, particularly Compton scatterings. The peripheral n^+ contact of a coaxial detector is split into two or more segments, and events are recorded from the central p contact if signals are coincidentally present on two segments of the n^+ contact. A sum signal is derived from the central p contact through a high resolution preamplifier, and individual localization signals are taken from each segment of the n^+ contact through simple voltage-sensitive preamplifiers. The maximum sensitivity of the system lies between 300 and 1300 keV where the Compton cross-section is dominant and many Compton scattered γ-rays are not sufficiently energetic to escape. The total absorption mode achieves about 20% of the photopeak efficiency of the detector operated in the normal singles mode. An increase in the ratio of the full energy peaks to the Compton continuum of 10:1 is found for ^{60}Co γ-rays, and it is significantly greater for γ-rays of less than 1 MeV. (auth)

23308 (BNWL-SA-1522) AN ANTICOINCIDENCE-SHIELDED Ge(Li) GAMMA-RAY SPECTROMETER FOR HIGH SENSITIVITY COUNTING. Cooper, J. A.; Wogman, N. A.; Perkins, R. W. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Mar. 25, 1968. Contract AT(45-1)-1830. 12p. (CONF-680207-5). Dep. CFSTI.

From 11th Scintillation and Semiconductor Counter Symposium, Washington, D. C.

An anticoincidence-shielded Ge(Li) gamma-ray spectrometer for high sensitivity counting is described. The system consists of a 20 cc coaxial diode centered inside a 26" diameter by 24" thick plastic phosphor. The source is placed inside the shield and both the coincidence and anticoincidence spectra are recorded simultaneously. The anticoincidence shield reduces the ^{137}Cs Compton edge by a factor of 7.5 to provide a peak to Compton edge ratio of 150:1 without reducing the photopeak efficiency by more than 3%. This system also provides a two to fourfold lower natural radionuclide background than similar sized diodes. (auth)

23309 (CEA-R-3300) STABILISATION DES SPECTRES FOURNIS PAR UN SPECTROMETRE A RAYONS GAMMA. APPLICATION A LA REALISATION D'UN STABILISATEUR. (Stabilization of Spectra Provided by a Gamma-Ray Spectrometer. Application to the Construction of a Stabilizer). Detourne, Guy (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). 1967. 93p. (In French). Dep.

Thesis. Submitted to Faculte des Sciences, Univ. of Paris, France.

The stabilization of spectra provided by a gamma-ray spectrometer is discussed. It is required to hold the calibration

straight line of the spectrometer in a position which is fixed initially to better than 5×10^{-5}/channel. A prototype numerical stabilizer has been constructed: the spectrostab; it is made up of two independent control loops; one of these makes the spectrometer gain depend on the derivatives of a reference peak at high energies; the other makes the origin of the energy scale depend on the derivatives of a second reference peak at low energies. A theoretical study of the behavior of a control loop shows that a direct action stabilizer gives the most accurate stabilization; the loss in resolving power on the theoretical peaks of the spectra attains about 1% with a scintillation detector, and 10% with a semi-conductor detector. Various tests show that the expected results are obtained and that the displacement of the spectral peaks produced by the derivatives are hidden by errors in the calculation of the peak abscissa. (auth)

23310 (IEA-136) EXPERIMENTAL STUDY OF A CURVED SLIT SLOW-NEUTRON CHOPPER AND TIME-OF-FLIGHT SPECTROMETER. Herdade, Silvio B.; do Amaral, Lia Q.; Rodriguez, Claudio; Vinhas, Laercio A. (Instituto de Energia Atomica, Sao Paulo (Brazil)). Feb. 1967. 76p. Dep.

The experimentally determined characteristics of a curved slit slow-neutron chopper and time-of-flight spectrometer, in operation at a beam hole of the IEAR-1 (5 MW swimming pool research reactor), are presented. A detailed treatment of the corrections for counting losses in the detecting system and multichannel analyser is presented. The calibration and resolution of the system are discussed. A total cross-section measurement of gold, in the range of 0.95 Å to 7.00 Å, has been carried out as a reliability check of the spectrometer. Fortran II-D programs for time-of-flight data processing and for total cross-section computation are also presented. (W.H.K.)

23311 KEYED STABILIZING SYSTEM FOR SINGLE-CHANNEL GAMMA-RAY SPECTROMETER. Dabek, Tadeusz (Inst. of Nuclear Techniques, Krakow); Korbel, Kazimierz. Nukleonika, 13: 125-30(1968).

The stabilizing system of a single-channel gamma-ray spectrometer based on the use of a pulse-height selector incorporated in the spectrometer assembly is described. The principle of operation of this device is based on the periodic switching of the analyzer threshold, shifting it alternately either to the measuring range or to the reference peak level. (auth)

23312 STATISTICAL FLUCTUATIONS IN THE NUCLEAR SPECTROMETRY PEAKS. Daddi, L.; D'Angelo, V. (Lab. of Physics, Pisa, Italy). Int. J. Appl. Radiat. Isotop., 19: 407-10 (Apr. 1968).

The statistical fluctuations of characteristic quantities of nuclear spectrometry peaks, such as the abscissa of the maximum, the full-width at half-maximum and the area, in the presence of different types and levels of background, were studied by a pseudo-experimental method. This study can serve in evaluating the utility of some devices frequently employed to reduce background or spurious spectral distributions. (auth)

23313 A BENT-CRYSTAL SPECTROMETER FOR THE MEASUREMENT OF K X RAYS COINCIDENT WITH FISSION. Wehring, B. W.; Wyman, M. E. (Univ. of Illinois, Urbana). Nucl. Instrum. Methods, 61: 189-97(May 1968).

A bent-crystal spectrometer of the Johansson type which was designed and constructed for the measurement of fission fragment K x rays coincident with fission is described. The spectrometer has a unique arm mechanism which permits the source to remain fixed as the Bragg angle is changed. The crystal of the spectrometer consists of 6 single crystals of LiF which were cleaved, bent, and bonded onto a single backing plate (11.4 by 17.8 cm). The surface of the LiF was then ground to the required radius of curvature (40 cm). In order to maintain sufficient sensitivity for the coincidence experiment resolving power was sacrificed. The resolving power, however, was still high enough to resolve the Kα lines of adjacent-Z light fragments. (auth)

23314 GAMMA-SPECTROMETRIC IDENTIFICATION OF FALLOUT NUCLIDES WITH A Ge(Li)-DETECTOR. Romantschuk, H.; Kauranen, P.; Rahola, Tua; Hattula, Tuulikki; Miettinen, J. K. (Univ. of Helsinki). Suomen Kem., B39: 182-3(1966).

A large rainwater sample was collected about one month after the detonation of the Chinese nuclear bomb on May 9, 1966. The sample was evaporated to dryness and the residue γ-counted using a Ge(Li)-semiconductor and a multichannel analyzer. Several fallout nuclides were identified solely on the basis of their γ-energies. ^{140}Ba was also determined by radiochemical separation. (auth)

23315 A 4$\pi\beta$-SPECTROMETER WITH Li-Si COUNTERS. Andersen, V.; Christensen, C. J. (Danish Atomic Energy Commission, Riso). Nucl. Instrum. Methods, 61: 77-83(Apr. 15, 1968).

A 4$\pi\beta$-spectrometer has been developed. Provided with solid-state detectors, it has a resolution of 2% at 1 MeV. Because of the 4π-geometry it is well suited for absolute measurements and for measurement of conversion coefficients. (auth)

23316 OPERATIVE CONDITIONS OF A DIFFUSION-WILSON CHAMBER FILLED WITH HYDROGEN AT A PRESSURE OF 0.1 ATMOSPHERE. Damyanov, D. B.; Tsupko-Sitnikov, V. M.; Shcherbakov, Yu. A. Izv. Fiz. Inst. Aneb, Bulg. Akad. Nauk., 16: 99-102(1967). (In Bulgarian).

By selecting suitable conditions of temperature at the bottom and at the cover of a diffusion chamber, the prerequisites were created for its stable operation upon filling with hydrogen at a relatively low pressure (0.1 at.) which in its turn provides for its utilization in the spectrometry of low-energy neutrons. (auth)

23317 LOW-LEVEL-γ-SPECTROSCOPY BY β-γ-COINCIDENCE TECHNIQUES. Roedel, W. (Univ., Heidelberg). Nucl. Instrum. Methods, 61: 41-4(Apr. 15, 1968).

It is pointed out that the sensitivity of a γ-spectrometer for low-level-counting can be improved by one or two orders of magnitude, when the β-radiation can be registered in coincidence. Design and construction of a β-γ-coincidence spectrometer, according to this principle, is described. Background and sensitivity of the single crystal γ-spectrometer, operated with and without anticoincidence shielding, as well as background and sensitivity of the coincidence spectrometer are discussed in detail. (auth)

23318 LIQUID SCINTILLATION SPECTROMETRY: A PRACTICAL APPROACH. Roberts, William A. (Beckman Instruments Ltd., Glenrothes, Scotland). Bio-Med. Eng., 2: 404-6 (Sept. 1967).

Advances in liquid scintillation techniques and apparatus are reviewed. New photomultiplier tubes are described which operate at ambient temperature, eliminating the need for freezing-point depressants in the scintillation mixture, and their extended wavelength response eliminates the need for a secondary fluor as a wavelength shifter. The new photomultiplier tubes have 2 important features: (1) A high quantum efficiency (typically 30% as against 22% in old-style tubes) bi-alkali photocathode. This produces nearly 40% more photoelectrons and therefore a larger pulse height for a given decay event. (2) Very fast pulse rise-time, so that the coincidence unit which follows the 2 photomultiplier tubes is much faster in operation than hitherto, and the number of random coincidences that are seen as true pulses is negligible. It is thus possible to operate at temperatures up to 40°C and use simpler scintillation mixtures, achieving a higher and constant sample solubility. Electronic components, including the coincidence unit, amplifiers, pulse-height analyzers, and scalers, are discussed with respect to recent innovations. (BBB)

High Energy Physics Instrumentation

Refer also to abstract 24570.

23319 (BNL-12374) A MAGNETIC FIELD FIT TO THE 30" BNL BUBBLE CHAMBER. Maynard, Jay; Nauenberg, Uriel (Princeton Univ., N. J. Palmer Physical Lab.); Berley, David; Campbell, Dean; Kasden, Abraham; Koehler, John; Majestic, Richard; Radlhammer, George (Brookhaven National Lab., Upton, N. Y.). Jan. 18, 1968. 37p. Dep. CFSTI.

The magnetic field of the BNL 30-inch hydrogen bubble chamber was measured on a 1 inch cubic lattice over the entire volume of the chamber. Three orthogonal components of the magnetic field were measured with three precisely oriented and calibrated Hall probes. A formula which describes the measurements to an accuracy of 0.2% and which satisfies Maxwell's equations exactly was derived. The coefficients of the field formula were adjusted with a program which utilizes the method of least squares. (auth)

23320 (CERN-68-4) THE HPD MARK 2 FLYING-SPOT DIGITIZER AT CERN. Benot, M.; Evershed, B. W.; Messerli, R.; Powell, B. W. (European Organization for Nuclear Research, Geneva (Switzerland)). Feb. 6, 1968. 85p. Dep.

The design and performance of the HPD Mark 2 flying-spot digitizer for automatic analysis of bubble chamber photographs are presented. The control system, generation of the spot coordinates, generation of the stage coordinates, the film transport, the input-output interface and buffer memory, machine control and system operation, adjustments and precision of the digitizings, and system testing are discussed. (W.H.K.)

23321 (CERN-68-10) CORRECTION FOR GEOMETRICAL LOSSES IN A BUBBLE CHAMBER. Holthuizen, D. J. (European Organization for Nuclear Research, Geneva (Switzerland)). Mar. 22, 1968. 27p. Dep.

The problem of evaluating particle tracks in a bubble chamber

that are in the direction of the magnetic field is studied. A method for calculating the weights to correct for lost events in a spherically symmetrical problem is presented, and calculations are checked using Monte Carlo techniques. (W.H.K.)

23322 (SLAC–81) COMPUTER-CONTROLLED SYSTEM FOR MEASURING BUBBLE CHAMBER AND SPARK CHAMBER FILM. Jensen, M.; Martin, F.; Mueller, E.; Salsburg, B. (Stanford Linear Accelerator Center, Calif.). Jan. 1968. Contract AT(04-3)-515. 16p. Dep. CFSTI.

A computer-controlled manual measuring system for measuring spark chamber and bubble chamber film, designed and constructed at SLAC is described. The basic components of this system are the ASI 6020 computer, the control program BUCAPS, and the high precision measuring projector with its control electronics. (W.H.K.)

23323 RANGE CHAMBER FOR ELECTRONIC READOUT. Coulson, L.; Grubb, W.; Minehart, R.; Ziock, K. (Univ. of Virginia, Charlottesville). Nucl. Instrum. Methods, 61: 209-12 (May 1968).

A 15-gap spark chamber with electronic readout has been constructed for use as a range chamber. Construction details, gas handling and electronic circuitry are described. Special precautions taken to reduce spurious background to a low level are also discussed. Tests of the chamber with cosmic rays and 30–60 MeV protons were made, and performance data are presented. At normal operating conditions, the breakdown efficiency per gap is 99.9% with protons and 99.3% with cosmic rays. Spurious breakdown is less than 0.03% per gap. (auth)

23324 MEASUREMENT OF NANOSECOND VERY HIGH VOLTAGE PULSES. Metzger, G. P.; Riedinger, M.; Schmitt, F. M.; Sutter, G. L. (Institut de Rercherches Nucleaires, Strasbourg. Univ., Mulhouse, France). Nucl. Instrum. Methods, 61: 226-8(May 1968).

An easy-to-build attenuator for the measurement of very high voltage pulses in the nanosecond range is described. (auth)

23325 LOW-DENSITY POLYURETHANE FOAM PLATE SPARK CHAMBER. Schnurmacher, G. L.; Clark, A. R.; Kerth, L. T. (Univ. of California, Berkeley). Nucl. Instrum. Methods, 61: 89-92(Apr. 15, 1968).

Development of a multi-gap, low-density visual spark chamber is described. The design has been used successfully to make spark chambers up to 2600 $in.^2$ in area with very uniform gap spacing. Individual plate thickness is approximately 0.125". Density per plate is approximately 29 mg/cm^3, or the radiation length equivalent to approximately 2 mil of aluminum. The chambers have been pulsed in a bevatron experiment over 2.5×10^6 times with good efficiency. (auth)

23326 NEW DETECTOR FOR RELATIVISTIC PARTICLES. Lorikyan, M. P. (Inst. of Physics, Erevan). Izv. Akad. Nauk Arm. SSR, Ser. Fiz., 2: 376-8(1967). (In Russian).

A new detector for the measurement of the energy of the relativistic particles is described. (auth)

Radiation Dosimeters

23327 (AED-C-21-06) BIBLIOGRAPHIEN ZUR KERNFORSCHUNG UND KERNTECHNIK. SEKTION 21: DOSIMETRIE. (Bibliographies in Nuclear Science and Technology. Section 21: Dosimetry). Becker, Klaus (comp.) (Zentralstelle fuer Atomkernenergie-Dokumentation, Frankfurt am Main (West Germany)). Jan. 1968. 87p. (In German and English). Dep.

A bibliography containing 317 articles on photographic, chemical, and solid-state radiation dosimetry is presented. An author index and a subject index are included. (W.H.K.)

23328 (IEA–141) CALIBRACAO DOS FILMES DU PONT TIPO 508 E 510 PARA A RADIACAO BETA. (Calibration of Types 508 and 510 Du Pont Film for Beta Radiation). Sordi, Gian Maria A. A.; Vizeu, Dirceu M. (Instituto de Energia Atomica, Sao Paulo (Brazil)). Apr. 1967. 25p. (In Portuguese). Dep.

The main difficulty in the calibration of the film is the calculation of exposure from beta sources, because the existing analytical expressions are not applicable directly in most of the exposure conditions. After a brief discussion concerning the analytical expression used, a program for the IBM-1620 II computer is shown. The selection of the radioisotopes, the experimental arrangement, and the results are discussed. Some considerations on the minimum energy that can be detected are also made. The comparison of the response curve for beta with that of gamma radiation from Co-60 shows that it is possible to find out the exposition, to know if it came from gamma or beta plus gamma radiation, and also to give an approximate value for the average effective energy of the incident radiation. (auth)

23329 (RISO–161) MANGANESE-ACTIVATED LITHIUM BORATE AS A THERMOLUMINESCENT DOSIMETRY MATERIAL. Christensen, P. (Danish Atomic Energy Commission, Risoe. Research Establishment). Oct. 1967. 29p. Dep.

The general thermoluminescence properties of $Li_2B_4O_7$: Mn, prepared by fusion of $Li_2B_4O_7$ and $MnCl_2$, $4H_2O$, were investigated. With 100 mg samples (14.2 mg/cm^2) of $Li_2B_4O_7$: Mn, containing 0.1% manganese by weight, and an initial heating rate of 19°C/sec, two glow peaks were obtained at approximately 60 and 220–240°C. The glow-peak positions and the thermoluminescence light yields of the two peaks were found to be highly dependent on the manganese content. Because of rapid decay of the low-temperature peak at room temperature, only the second peak was of interest for dosimetry. Orange-yellow light, changing to yellow-green, was visually observed to be emitted from this peak. The response to Co-60 gamma radiation was linear up to about 300 rads, where supralinearity started. Saturation was reached at approximately 3×10^6 rads. The glow-peak area for a phosphor with a manganese content of about 0.5% was about ⅓ that of LiF (TLD-700) at small doses. The sensitivity of the phosphor was independent of heat treatments in the temperature range 80–400°C and of previous gamma-ray exposures up to 3×10^7 R. A small thermoluminescence signal, introduced by exposure to light, could be quenched by adding methanol containing a few per cent hydrochloric acid. It is concluded that $Li_2B_4O_7$: Mn, a rather inexpensive, promising luminophor with attractive dosimetry properties such as energy-independent response, indifference to large pre-irradiation doses as well as previous annealing, and only slight fading, might be a favorable alternative to LiF as a dosimetry material. (auth)

23330 THERMOLUMINESCENCE DOSIMETRY: PRESENT KNOWLEDGE AND PRACTICAL APPLICATIONS. Maushart, R.; Piesch, E. (Kernforschungszentrum, Karlsruhe, Ger.). Glas-Instrum.-Tech., 970-8(Oct. 1967). (In German). (KFK-686).

The use of film badges for checking the radiation to which personnel has been exposed is unsatisfactory because the range is rather limited and influenced by energy; furthermore, the results depend on the direction of the radiation. Evaluation of the results is rather expensive, time consuming and, in any case, not too accurate. Film badges cannot be re-used. Hence the search for more suitable methods continues. A promising and much discussed method depends on thermoluminescence. The state of development is reported. (auth)

23331 INSTRUMENTS FOR MEASURING THE NEUTRON REM DOSE AND THEIR APPLICATION. Atomtech. Tajek., 10: 697-704(1967). (In Hungarian).

During the last few years a new series of neutron dosimeters appeared on the market; they are characterized by the fact that they measure the biological dose expressed in rem, rather than the absorbed dose measured in rad. The neutrons are measured by a thermal-neutron detector incorporated in a moderating material, such as paraffin or polyethylene, which slows down the intermediate and fast neutrons. The instruments also follow the rem dose curve which takes into account the multiple collisions. Use of the moderator makes it possible to carry out detections through eight or nine orders of magnitude. This advantage is achieved at the cost of increased weight and more difficult handling. Structural details of several instruments are compared. Use of such moderated rem instrument is recommended primarily for heavily shielded large neutron sources, such as reactors. (TTT)

23332 G(Fe^{3+}) YIELD OF THE FRICKE–MILLER FERROSULPHATE DOSIMETER FOR 60 keV X-RAYS FROM AN X-RAY TUBE. Novotny, J.; Spurny, Z. (Czechoslovak Technical Univ., Prague. Inst. of Nuclear Research, Prague). Int. J. Appl. Radiat. Isotop., 19: 403-6(Apr. 1968).

The ferrosulphate dosimeter yield for x radiation of effective energy 62 keV, from a 250 kV x-ray tube was established, using a calorimeter to measure the absorbed dose. The value is compared with other published data. (auth)

23333 PHOTOSENSITIVITY OF CLEAR PERSPEX DOSIMETERS. Whittaker, B. (Atomic Energy Research Establishment, Wantage, Eng.). Int. J. Appl. Radiat. Isotop., 19: 427(Apr. 1968).

Comments are made on a letter by C. G. Orton concerning the present author's paper of the above title (Int. J. Appl. Radiat. Isotope 18: 89(1967)). (auth)

23334 METHOD BASED ON THE SIMILARITY OF RADIATION FIELDS FOR ADJUSTING AND VERIFYING DOSIMETRIC INSTRUMENTS. Garapov, E. F.; Dorofeev, G. A.; Lebedeva, M. A. Izmer. Tekh., No. 1, 65-7(Jan. 1968). (In Russian).

Calibration of dosimetric instruments in all of the energy ranges requires ^{60}Co source with a γ activity up to 3.7×10^{12} sec^{-1}, amounting to 100 Ci. It was found more convenient to calibrate the instruments only in the sensitive range, following up with an adjustment in other ranges on the basis of measurements with a set of similar γ sources of different activities. Use of only 3 or 4 sources with activity ratios of $A_1 : A_2 A_3 : A_4 = 1:3:10:30$ was found satisfactory. The activity of the ^{60}Co source should not exceed 1 Ci and that of the set 2 Ci. The incremental error of verification of the measurements by such a set does not exceed 2 to 3%, even though the instruments are able to measure very large exposure dose rates of the order of tens of thousands of μR/sec. (TTT)

23335 INVESTIGATIONS ON THE THERMOLUMINESCENCE OF $CaSO_4$:Mn WITH A VIEW TO ITS APPLICATION IN DOSIMETRY. Mishev, Iliya; Radicheva, Marina; Levi, Samuil; Zhelyazkov, Vasil. Izv. Fiz. Inst. Aneb, Bulg. Akad. Nauk., 16: 35-40(1967). (In Bulgarian).

The investigation covers a number of properties of powdered $CaSO_4$:Mn obtained by suitable processes, for the purpose of its application in dosimetric investigations. A higher upper limit of the possible measurement interval was obtained by a dosimeter made of the proposed phosphor on account of the fact that saturation is reached only after irradiation with 30,000 R. (auth)

23336 REGISTRATION OF FISSION-FRAGMENT TRACKS IN Th- OR U-DOPED PHOSPHATE GLASSES AND ITS POSSIBLE APPLICATION TO NEUTRON DOSIMETRY. Yokota, R.; Nakajima, S.; Muto, Y. (Tokyo Shibaura Electric Co. Ltd.). Nucl. Instrum. Methods, 61: 119-20(Apr. 15, 1968).

New Th- or U-doped phosphate glasses can register the fission-fragment tracks in a neutron field, and the etch pits can be visualized with an optical microscope. (auth)

23337 RADIOLUMINESCENCE OF THE PHOTOGRAPHIC FILM BACKING. Kartuzhanskii, A. L.; Matvienko, V. I.; Tregubova, T. M.; Shur, L. I. Zh. Nauch. Prikl. Fotogr. Kinemotogr., 13: 55-6(Jan.-Feb. 1968). (In Russian).

Measurements were made on the effects of temperature on radiophotoluminescence of materials used as backing for photographic film dosimeters, and data are presented for radiophotoluminescence intensity as a function of temperature in combustible and noncombustible film backing materials. (R.V.J.)

23338 CHEMICAL DOSIMETRY. Bhattacharyya, S. N.; Dutta, K. N. (Saha Inst. of Nuclear Physics, Calcutta). J. Sci. Ind. Res., 26: 147-52(Apr. 1967).

Some of the salient features of the Fricke dosimeter are described. The various systems developed for low and high dose measurements are discussed. (B.G.D.)

23339 IMPROVEMENTS IN OR RELATING TO IONISATION CHAMBERS. Betchev, Georges; Chameroy, Jean; Joffre, Henri; Laxague, Jean (to Commissariat a l'Energie Atomique). British Patent 1,108,583. Apr. 3, 1968. Priority date June 11, 1964, France.

A tissue-equivalent ionization chamber is described for beta particles and photons. The wall and collective electrode are made of a mixture of polyethylene and magnesium fluoride. (W.H.K.)

23340 LOGARITHMIC CURRENT AMPLIFIER. Lyden, Anders Gustav; Dissing-Sorensen, Erik (to Aktiebolaget Atomenergi). British Patent 1,110,354. Apr. 18, 1968. Priority date Feb. 19, 1965, Sweden.

A logarithmic current amplifier is described for use especially but not exclusively for radiation dose rate meters. The dose rate meter composed mainly of a boron trifluoride proportional counter is used for neutrons in proximity of accelerators, nuclear reactors etc. (B.G.D.)

23341 PHOTO-STIMULATED RADIATION DOSIMETRY. Miyashita, K. (to United States Atomic Energy Commission). U. S. Patent 3,375,372. Mar. 26, 1968.

This patent relates to a method for measuring ionizing radiation dosage comprising the steps of applying an electric field and infrared light to a radiation sensitive crystal having a wide band gap, deep carrier traps and high charge carrier mobility; exposing said crystal to ionizing radiation in the absence of electric field and infrared light; applying an electric field and infrared light to said crystal; and measuring the amplitude of the resulting current transient. (AEC)

Radiometric Instruments

Refer also to abstracts 23147–23151 and 23829.

23342 APPARATUS FOR β PARTICLES BACKSCATTERING ANALYSIS IN MIXTURES OF CLOSE ATOMIC NUMBERS. Parus, Jozef; Kowalski, Zdzislaw; Ney, Wlodzimierz (Inst. of Nuclear Research, Warsaw). Chem. Anal. (Warsaw), 13: 39-47(1968). (In Polish).

Construction and principles of operation of the apparatus for rapid determination of elements by β-particles scattering method is described. The apparatus makes possible the determination of the constituent that has effective atomic number only slightly higher than atomic number of the matrix. Ionization chambers operating in compensation system were used as detectors, and and $^{90}Sr + ^{90}Y$ as a source of β particles. The construction assuring optimum operating conditions as well as principles of sample preparation and calibration methods are discussed. General suggestions on the possibilities of utilization of the apparatus are given. (auth)

23343 APPLICATION OF RADIOACTIVE THICKNESS GAUGES TO THE RATIONALISATION OF TEXTILE PLANTS. Waechter, K. H. (Frieseke and Hoepfner GmbH, Erlangen, Ger.). Kerntechnik, 10: 86-91(Feb. 1968). (In English and German).

The great success of surface-density gauges using nuclear radiation in the textile industry is demonstrated by means of some practical applications. The technical and economical advantages of this method are stressed. In addition, the radiation protection provisions to be applied are dealt with. (auth)

23344 RADIOMETRIC METHOD OF DETERMINATION OF THE SPATIAL DISTRIBUTION OF DENSITY IN CLOSED MEDIA. Michalik, Alicja; Praxmayer, Tadeusz; Przewlocki, Kazimierz (Inst. of Nuclear Techniques, Krakow). Nukleonika, 13: 107-14 (1968).

A method is described for determining a density distribution function in a sample from measurements made outside the sample. A single detector–source system for continuous all-round scanning in about two minute cycles is presented. Methods of handling data are discussed. (auth)

23345 EFFECTIVENESS OF ISOTOPIC THICKNESS GAGES IN THE HUNGARIAN INDUSTRY. Abelovszky, Laszlo; Gozsy, Gabor. Atomtech. Tajek., 10: 645-50(1967). (In Hungarian).

The isotopic thickness gages, of which 31 were installed in Hungarian plants by 1966, were used to assist with the automatization of the steel, rubber, and plastics industries. Studies on the economic effects of these devices in rolling mills revealed that they helped to increase the capacity of the plant, resulting in higher production rate, reduction in the amount of rejects, and improvement in the accuracy of custom-made products. The material yield was also increased while the unit costs of the manufactured goods were reduced. Use of isotopic thickness gages presents economic and engineering advantages in all continuous manufacturing processes, justifying their introduction also in the paper and sheet glass industry. Among the engineering advantages, the reduction of the wear of tools and elimination of excessive weights in machine design should be mentioned. Especially satisfactory results, both in savings of costs and in the maintenance of the required close design tolerances were achieved in the sheet rubber manufacturing plant of the National Rubber Company. (TTT)

23346 SCINTILLATION TECHNIQUES IN SOIL-MOISTURE AND DENSITY MEASUREMENTS. Jensen, P. A.; Somer, E. (Danish Isotope Centre, Copenhagen). pp 31-46 of Isotope and Radiation Techniques in Soil Physics and Irrigation Studies. Vienna, International Atomic Energy Agency, 1967.

From Symposium on the Use of Isotope and Radiation Techniques in Soil Physics and Irrigation Studies, Istanbul. See STI/PUB-158; CONF-670641.

The application and advantages of a neutron-moisture gage making use of a scintillation detector with a lithium-6-glass scintillator are reported. Based on theoretical calculations and experimental results the influence of source-detector geometry, density effects, soil composition, and instrumental instabilities is discussed. With the instrumentation described simultaneous density and moisture measurements can take place by means of a gamma source unit which can be attached to the moisture probe. Backscattered gamma radiation giving information on density and slow-neutron radiation containing moisture information are both detected by the glass scintillator. The two signals are separated in the indicating instrument by means of pulse-height analysis. A technique that permits moisture measurements uninfluenced by density variations is described. The sensitivity to epithermal neutrons of the glass scintillator is made use of in a version of the instrument where the scintillator is shielded by a strong slow-neutron absorber. This results in insensitivity to neutron absorbers in the soil at the cost of a higher density influence and six to seven times longer counting times to reach a given accuracy.

Finally, a simple method for testing and adjusting the stability of the instrumentation is reported. (auth)

23347 DETERMINATION OF THE CALIBRATION CURVE FOR THE NEUTRON-MOISTURE METER BY CHEMICAL ANALYSIS OF SOILS. Couchat, P. (Centre d'Etudes Nucleaires, Cadarache, France). pp 67-82 of Isotope and Radiation Techniques in Soil Physics and Irrigation Studies. Vienna, International Atomic Energy Agency, 1967. (In French).

From Symposium on the Use of Isotope and Radiation Techniques in Soil Physics and Irrigation Studies, Istanbul. See STI/PUB-158; CONF-670641.

The main difficulty in using the neutron moisture meter in agronomy lies in the establishment of a calibration curve. The normal gravimetric method, whether carried out in the laboratory or in the field, involves a long and costly operation; moreover, it provides little information on the cause of the variations observed in terms of either the dry density or the type of soil. Theoretical investigations conducted in parallel with experiments seem to offer a good approach to determining the influence of the measuring parameters on the response of the moisture meter. The three-group theory of neutron diffusion is used to construct a mathematical model representing the moisture meter and the medium studied (defined by its overall chemical composition). This model is applied using a Fortran IV computer program, by which it can be adapted by experimental studies on the influence of geometry and the nature of the measuring system. Allowance has already been made for thermal flux depression and spread due to the presence of tubing, the emission spectrum of the source, and the yield and the energy level of detection of the counters. Particular reference must be made to the importance of epicadmium neutrons (energy above 0.4 eV). To compare the theoretical and experimental data, a method of representation is defined whereby it is possible to assess the ability of the model to account for the results obtained with seven different media (siliceous sand, alumina, limestone, dolomite, kaolin, chalky clay, and silt) defined by their overall chemical composition. For utilization in agronomy, the response of the moisture meter coincides with the calculated figures to roughly ±5%. Study of the effect on dry density suggests a general equation for the calibration curves of the form $N = f(H_V, \rho_S, \alpha, \beta, \gamma, \delta)$, where H_V = moisture content per volume, ρ_S = dry density, and α, β, γ, and δ are constants obtained from calculations based on chemical analysis of the soils. (auth)

23348 INFLUENCE OF BULK DENSITY, SLOW NEUTRON ABSORBERS, AND TIME ON THE CALIBRATION OF NEUTRON-MOISTURE PROBES. McHenry, J. R.; Gill, Angela C. (Dept. of Agriculture, Oxford, Miss.). pp 83-97 of Isotope and Radiation Techniques in Soil Physics and Irrigation Studies. Vienna, International Atomic Energy Agency, 1967.

From Symposium on the Use of Isotope and Radiation Techniques in Soil Physics and Irrigation Studies, Istanbul. See STI/PUB-158; CONF-670641.

A change in bulk density of a soil will affect significantly the neutron calibration curve only when the change per unit volume of the non-water hydrogen atom content is equivalent to or greater than the minimum detectable volume percentage of soil moisture. Measurements of the slow neutron flux in a block of Grenada silt-loam soil at differing bulk densities substantiated these conclusions. A system capable of simulating soil of varying moisture content was developed and evaluated for measuring the long-term effect of instrument-component variation on reproducibility of a neutron-calibration curve. The effect of differing concentrations of neutron absorbers was also simulated. Elements which are neutron absorbers exist in some soils but will seldom be in quantities sufficient to affect significantly the neutron-calibration curve. Three types of neutron probes were evaluated. While characteristics of the respective calibration curves varied, the reliability with time of all neutron probes tested was satisfactory. (auth)

23349 COMPARISON OF THREE METHODS OF MEASURING SOIL MOISTURE. Hajdukovic, M.; Jakovljevic, M.; Vajgand, V. (Inst. for the Application of Nuclear Energy in Agriculture, Veterinary Medicine, and Forestry, Belgrade). pp 117-24 of Isotope and Radiation Techniques in Soil Physics and Irrigation Studies. Vienna, International Atomic Energy Agency, 1967.

From Symposium on the Use of Isotope and Radiation Techniques in Soil Physics and Irrigation Studies, Istanbul. See STI/PUB-158; CONF-670641.

In field conditions on pseudo-gley soil, by applying intensive liming and deep ploughing, the soil moisture was measured continuously by the following methods: (a) gypsum-block electrical resistance, (b) neutron-scattering, (c) fibre-glass electrical resistance, and (d) the gravimetric method as a control. The gypsum blocks used were made by the authors. The neutron-scattering method was carried out by using a Nuclear Chicago Moisture Meter, model 2800 A, together with the model P-19 probe including one 5-mCi radium-beryllium source and one $^{10}BF_3$ detector tube. The thermistor method was carried out with fiber-glass blocks made by Soiltest Incorporated, Chicago. The results obtained indicated the advantages as well as the disadvantages of each of the methods used. The gypsum-block resistance method was found to be quick, relatively cheap, and suitable for the reclamation systems. However, it appeared to be very sensitive to the composition of the soil solution. The results obtained by this method were accurate only within field capacity and wilting point of the aforementioned soil. The appearance of hysteresis during the rapid soil-drying was also noticed. The neutron-scattering method is very accurate, applicable to all soil types as well as to the degree of soil moisture; but the equipment is rather expensive. The thermistor method served only as a correction for the electro-resistance in gypsum blocks. (auth)

23350 EVAPOTRANSPIRATION STUDIES ON MAIZE IN GIZA, UNITED ARAB REPUBLIC. Zein el Abedine, A.; Abdalla, M. M.; Abdel-Al, Sh. I. (Middle Eastern Regional Radioisotope Centre, Cairo). pp 357-78 of Isotope and Radiation Techniques in Soil Physics and Irrigation Studies. Vienna, International Atomic Energy Agency, 1967.

From Symposium on the Use of Isotope and Radiation Techniques in Soil Physics and Irrigation Studies, Istanbul. See STI/PUB-158; CONF-670641.

Evapotranspiration studies of main crops are important to the development of crop production in countries with limited water resources. Through these studies sound and efficient water use policies can be planned to achieve the best use of water resources. Three methods of measuring evapotranspiration of maize are described. They include direct measurement through the daily weighing of hydraulic lysimeters; indirect, by measuring the moisture changes in the profiles with neutron-moisture meter; and computing the potential evapotranspiration (E.T.) after the method of Penman from climatological data. Two levels of irrigation used included irrigation to field capacity once 0.4 of the available moisture in the root zone was depleted, and irrigation to field capacity when 0.7 of the available moisture was depleted. One hydraulic lysimeter and five plots were used for each treatment. The results showed that for the whole growing season the evapotranspiration measured by the method of Penman agreed well with that obtained from the lysimeters. The results of measurements using the Penman E. T. method were higher at the beginning of the growing season, lower in the middle, and about the same at the end. The E. T. measured by the neutron-moisture meter also agreed well with the actual one. The neutron-meter measurements were 0.93 of the actual E. T. in both lysimeters. The data obtained from plots indicate that a considerable amount of water was used by the plants from the fringe of the water table. The growth and yield of maize were affected by the two levels of irrigation; the greater depletion produced crops 13 to 18% less than that of the other treatment. Thus the Penman E. T. and moisture measurements by the neutron-moisture meter can be used after special corrections, at least under conditions similar to those of the experimental site. (auth)

23351 DRY-MATTER PRODUCTION IN IRRIGATED CROPS IN THE ARID MEDITERRANEAN ZONE. Damagnez, J. A. (Centre de Recherches Agronomiques du Sud-Est, Montfavet, France). pp 343-55 of Isotope and Radiation Techniques in Soil Physics and Irrigation Studies. Vienna, International Atomic Energy Agency, 1967. (In French).

From Symposium on the Use of Isotope and Radiation Techniques in Soil Physics and Irrigation Studies, Istanbul. See STI/PUB-158; CONF-670641.

The water-balance equation for crops was applied to research on the water requirements of crops in the arid Mediterranean zone and the effectiveness of the water according to the season. The neutron probe was used to determine variations in the groundwater reserve. The method used resulted in an error in estimation of the variations in groundwater reserves in the zone penetrated by the roots not exceeding 10 mm of water. For fodder crops that undergo successive cuttings (sorghum, lucerne) the method used disclosed some outstanding facts that may be confirmed by theoretical study of the equation for the production of dry matter. These results show in particular that there is a simple relation between the yield and the water consumption or true evapotranspiration (ETR). Nevertheless, for a given quantity of water added to the soil (rainfall + drainage), the demand made by the crop on the groundwater reserves varies in particular with the level of these reserves and with the root development. An important finding was that the maximum yield, obtained when ETR = ETP (potential evapotranspiration), decreased as the ETP values increased.

For large ETP values, when the light factor did not limit photosynthesis, the product (ETP × yield) was relatively constant. Therefore, high potential evapotranspiration values appear to be an important limiting factor in the production of dry matter in the arid Mediterranean zone. A number of agronomic solutions are suggested. (auth)

23352 NEUTRON-MOISTURE-METER INVESTIGATION OF WAYS IN WHICH DRY AND IRRIGATED CROPS UTILIZE SOIL MOISTURE. Maertens, C. E.; Courau, M. (Institut National de la Recherche Agronomique, Toulouse). pp 391-8 of Isotope and Radiation Techniques in Soil Physics and Irrigation Studies. Vienna, International Atomic Energy Agency, 1967. (In French).

From Symposium on the Use of Isotope and Radiation Techniques in Soil Physics and Irrigation Studies, Istanbul. See STI/PUB-158; CONF-670641.

The preparation of numerous water balances with the aid of a neutron-moisture meter made it possible to determine the accuracy of this type of instrument and the best way of using it in agronomical work. These data were used in a critical study of the concept of water reserves utilizable by plants, and to demonstrate the effects of root development on water use. It is shown that the effectively available water reserves vary considerably throughout the plants' growth. Irrigation modifies the environmental conditions; the more intensive the irrigation, the less the groundwater reserves contribute to the plants' supply. A study of several types of soil showed that the physical properties of the soil influence yields, even in the case of irrigated crops. In fact, serious growth anomalies were observed after the irrigation of degraded soils. A knowledge of the physical properties and potentialities of root growth is therefore essential for rational irrigation. (auth)

23353 TUBER FORMATION IN POTATOES AS AFFECTED BY SOIL MOISTURE. Danfors, L. E.; Gustafsson, N. (Inst. of Technology, Stockholm. Inst. for Plant Research and Cold Storage, Nynashamn, Sweden). pp 379-90 of Isotope and Radiation Techniques in Soil Physics and Irrigation Studies. Vienna, International Atomic Energy Agency, 1967.

From Symposium on the Use of Isotope and Radiation Techniques in Soil Physics and Irrigation Studies, Istanbul. See STI/PUB-158; CONF-670641.

In potatoes, tuber formation is generally confined to the top 10 cm of the soil, while root development is concentrated in layers below this depth. An experiment was designed primarily to study how the soil-moisture climate of the tuber zone would affect potato growth. A common root zone was chosen by setting the seed tubers on the surface of a loam soil. On top of this a 10 cm soil layer was placed to act as a tuber zone. Soil texture and moisture were the factors used to establish four different physical environments of the applied top layer. Soil moisture was regulated throughout the growing season by means of the neutron method. Potato growth was studied by means of successively harvesting the treatment plots. Various growth development stages could be differentiated where the moisture climate had significant effects not only on the rate, but also on the nature, of the growth and the state of health of the potato plants. (auth)

23354 VENTING APPARATUS AND CLEANING PROCEDURE FOR ELECTRON CAPTURE DETECTORS. Claeys, Robert R.; Farr, Tommy (Oregon State Univ., Corvallis). Anal. Chem., 40: 847-8(Apr. 1968).

Two developments are described which lead to a large increase in the linear response range and a reduction in noise and base-line drift in tritium-source electron capture detectors. The first development is an improved cleaning procedure for tritium foils, and the second is the addition of a carrier gas venting apparatus. The carrier gas is shunted into the atmosphere instead of passing through the detector during idle periods or when the solvent and contaminating materials are eluted from the column. The new cleaning technique results in a cleaner foil, and the venting arrangement reduces foil contamination from column bleedoff or the elution of contaminants. (auth)

23355 INCREASING THE RELIABILITY OF THE RADIOISOTOPE RELAY APPARATUS. Buchvarov, Nikolai. Izv. Fiz. Inst. Aneb, Bulg. Akad. Nauk., 16: 117-27(1967). (In Bulgarian).

A brief description is presented of the investigations undertaken with the aim of raising the reliability of the radioisotope relay apparatus. A universal radioisotope relay apparatus was built as a result of the investigations. Its structure has been simplified to the maximum, being composed of a minimum number of active elements—only three transistors and one halogen counter—and providing for the adjustment of sensitivity, the threshold, and the time of actuation and relaxation. The possibility is also provided of incorporating one or two probes connected after an AND diagram or after an OR diagram and taking them several hundred meters from the electronic block to which they remain connected by means of an ordinary twocore shielded cable. With the purpose of further increasing the reliability of this type of apparatus, a special control signal has been provided which is constantly indicating whether the apparatus is in good working order. The pulses obtained from the halogen counter are used as such a signal. The pulses stop when the apparatus is out of order, a sound signal is switched on, and, if necessary, a stand-by unit may be switched on. (auth)

23356 IMPROVEMENTS IN OR RELATING TO GAS IONISATION DETECTORS. Lovelock, James Ephraim (to W. G. Pye and Co., Ltd.). British Patent 1,107,367. Mar. 27, 1968. Filed Dec. 19, 1963.

An apparatus for detecting the quantity of an impurity present in a gas is described. The system consists of a flowthrough ionization-type chamber with a radiation source positioned inside. (W.H.K.)

Miscellaneous Instruments and Components

Refer also to abstracts 23218, 23711, 24110, 24249, 24281, and 24473.

23357 (COO-1721-2) ELECTRON MICROSCOPE STUDIES. Technical Progress Report, June 1, 1967-May 31, 1968. Crewe, Albert V. (Chicago Univ., Ill. Enrico Fermi Inst. for Nuclear Studies). Feb. 1968. Contract AT(11-1)-1721. 16p. Dep. CFSTI.

Electron microscopy research and development at the University of Chicago is outlined. Topics discussed include laboratory facilities, 30 kV microscope, 100 kV gun, field emission gun microscope, automatic camera, and theoretical studies. A listing of personnel and a bibliography of published works are also presented. (W.H.K.)

23358 (IA-1128, pp 185-212) INSTRUMENTATION AND ELECTRONICS. (Israel Atomic Energy Commission, Tel Aviv).

Various types of electronic equipment and measuring instruments are discussed. Some of these include beta spectrometers, semiconductor detectors, pulse analyzers, reactor pneumatic systems, electrometers, temperature control equipment, power supplies, and equipment for studying sealing mechanisms of vacuum gasket seals. (B.G.D.)

23359 (JINR-E14-3759) FOCUSING OF THE TIME-OF-FLIGHT DIFFRACTOMETER FOR STRUCTURE ANALYSIS: THE EXPERIMENTAL CHECK. Holas, A.; Holas, J.; Maliszewski, E.; Sedlakova, L. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Neutron Physics). 1968. 30p. Dep.

The experimental check of focusing of the neutron time-of-flight diffractometer for crystal structure analysis is presented. The obtained results proved the formulae for focusing. The intensity of the focused diffractometer increased by an order of magnitude as compared with the previous diffractometer (with collimators) of the same resolution. (auth)

23360 (MATT-Q-25, pp 341-6) POWER ENGINEERING. (Princeton Univ., N. J. Plasma Physics Lab.).

Brief discussions of research are given for the following: (1) inductive circuit switch, (2) an inductive energy storage system using ignitron switching, and (3) some engineering problems of thermonuclear reactors. (M.O.W.)

23361 REMOTE CONTROL NUCLEAR MAGNETOMETERS. Denisov, Yu. N.; Ivashkevich, S. A. Izmer. Tekh., No. 2, 56-7 (Feb. 1968). (In Russian).

Descriptions are given of two types of remote control NMR magnetometers designed for measuring stationary magnetic fields in small electromagnets and in magnets with pole pieces up to several meters. (R.V.J.)

23362 DEVICE FOR THE REPRESENTATION IN PLAN OF RADIATION EMITTED BY AN OBJECT. Leroy, Marcel (to Commissariat a l'Energie Atomique). British Patent 1,110,236. Apr. 18, 1968. Priority date Nov. 10, 1964, France.

A device is described for representation in plan of radiation emitted by an object, whereby the levels of radiation intensity which are comprised within different predetermined ranges are represented by different colors. One application described is in medical diagnostics, in which it is important to obtain a diagrammatic representation of local variations in the fixation of a radioactive tracer which can be interpreted without difficulty.

A diagram of this type, or so-called cartogram, is built up by means of a scanning process. (B.G.D.)

23363 LASER MICROPROBE FOR SPECTROGRAPHIC ANALYSIS. Trucco, R. (CISE, Milan). Energ. Nucl. (Milan), 15: 277-81(Apr. 1968).

A new equipment for microanalysis is described. The coupling of a traditional emission spectrograph with a laser power source and a metallographic microscope allows to obtain an analytical tool with characteristics peculiar to a microprobe. Mechanical, optical, and electronic components of the microanalyser are described in details. In designing the equipment, the part concerning optical microscopy was emphasized. In fact, it is possible to carry out accurate and exhaustive investigations on purposely prepared metal samples. The equipment performances are studied with reference to the laser beam quality, its focalisation on the sample, the result obtainable by fusion of a small area of the sample itself. Finally, series of optical micrographies are reported illustrating the geometry of craters produced on metallographic samples by means of the described microprobe. (auth)

23364 USE OF LABELED PULSER PULSES AS AN AID IN MONITORING THE QUALITY OF NUCLEAR PHYSICS EXPERIMENTS. Frederick, D. E.; Hildebrand, J. R. (Ames Lab., Iowa). Nucl. Instrum. Methods, 61: 205-8(May 1968).

Analog pulses from a stable, externally triggered pulse generator were provided with an associated, time-coincident logic pulse for labeling. When suitably shaped and mixed with nuclear event produced pulses, these pulser pulses were used in multidetector arrays to aid in gain stabilization of each chain of electronics, to sample electronic deadtimes, and to measure the resolution broadening and gain shifts introduced by pulse pile-up. Use of these pulses also permitted observation of the effective lower and higher kinetic energy spectrum limits in $\Delta E \times E$ telescopes. For large data acquisition systems, labeled pulser pulses allow checking of the linear electronics and computer interface operation and are invaluable by providing idiot checking capability needed to minimize human errors during long accelerator runs. (auth)

23365 ULTRASOUND CAMERA. Sayers, J. F. (Atomic Energy Research Establishment, Harwell, Eng.). pp 97-127 of Physics and Nondestructive Testing. McGonnagle, W. J. (ed.). New York, Gordon and Breach, Science Publishers, Inc., 1967.

From Symposium on Physics and Nondestructive Testing, Dayton, Ohio. See CONF-748.

Experimental work on the production of acoustic images and their conversion into visible images by a converter tube is described. The motive for the work is to find an improved method of ultrasonic flaw detection. The picture signal is produced by the image converter tube, using a modified form of cathode potential stabilization. Other workers in this field have used secondary emission to produce the picture signal. Potentially useful results have been obtained from the examination of metal to metal bonding in reactor fuel plates, using continuous wave ultrasound. Satisfactory pictures have not been obtained from thick metal sections, due to the presence of undesired reflections. The possibility of overcoming this disadvantage by constructing a pulse echo camera using a cathode potential stabilized tube is discussed. (auth)

23366 ION OPTICS OF MASS SPECTROMETERS. I. ELECTROSTATIC FIELDS. Rao, B. S. Prahallada (Atomic Energy Research Establishment, Harwell, Eng.). J. Phys., D, 1: 99-112 (1968). (AERE-R-5185).

The ion-optical properties of the radial electrostatic field analyzer have been studied by several workers and appear mainly in the form of mathematical formulae. Some of these properties are re-examined and are presented graphically over ranges of values of several parameters. This should be helpful when selecting values of these parameters for a design. (auth)

23367 STORAGE COUNTERS USING FET'S. Takeuchi, Satoshi; Nishino, Osamu (Tokyo Univ.). Oyo Butsuri, 36: 982-7(Dec. 1967). (In Japanese).

The characteristics, modification, and uses of a transistorized storage counter are described. The circuit uses a MOS type FET as a memory voltage reading element. The memory voltage decay rate is better than -0.1%/min at 30°C, 63% R.H. Because it is simple, compact, and light weight, the circuit will have many uses in nuclear instrumentation. By a modification of the pumping circuit of the storage counter, it can also serve as a pulse integrator for radiation dosimetry. Also, a simple 15-channel pulse-height analyzer utilizing the storage counters as memory devices has been constructed. (auth) (NSA of Japan)

23368 COUNT-RATE DEPENDENCE OF THE GAIN OF RCA 7046 PHOTOMULTIPLIERS FOR FIXED DYNODE POTENTIALS. Weitkamp, C. (Oak Ridge National Lab., Tenn.); Slaughter, G. G.; Michaelis, W.; Schmidt, H. Nucl. Instrum. Methods, 61: 122-4 (Apr. 15, 1968). (ORNL-P-3648).

The gain of RCA 7046 photomultipliers is constant for loads up to about 4% of the maximum permissible anode current and drops by about 8% at maximum load. Gain adjustment time constants $\lambda_1 = 2.65$ min, $\lambda_2 = 18.5$ min and $\lambda_3 = 307$ min depend very little on the individual tube and the sign of the load change; this seems not to be true for a fast ($\lambda_0 \ll 2$ min) component. Dynode voltages were stabilized by means of six cathode-followers. (auth)

23369 MEASUREMENT OF HALF-LIVES OF ISOMERIC NUCLEAR STATES BY A METHOD OF TIME INTERVAL ANALYSIS. Tatcher, M.; Lindeman, H. (Technion-Israel Inst. of Tech., Haifa). Nucl. Instrum. Methods, 61: 58-60(Apr. 15, 1968).

The half-life of the isomeric state in ^{208}Pb has been measured by a method based on analyzing the integral distribution of time intervals between successive pulses from a single detector. The principles of the method and its applicability to the determination of the half-lives of long-lived states populated in the decay of radioactive sources are discussed. (auth)

23370 CHARGED PARTICLE POLARIMETER FOR USE WITH A MAGNETIC SPECTROMETER. Gurd, D.; Roy, G.; Leighton, H. (Univ. of Alberta, Edmonton). Nucl. Instrum. Methods, 61: 72-6(Apr. 15, 1968).

A charged-particle polarimeter is described which uses proton elastic scattering from a 17 mg/cm^2 carbon foil as an analyzer. Charged-particle groups are selected by a 50 cm magnetic spectrometer, and doubly scattered particles are detected in 10 mm silicon surface barrier detectors. An analyzing power of 68% is achieved for protons entering the polarimeter in the energy range from 5.4 to 6.0 MeV. (auth)

23371 OPTIMUM PROCESSING FOR AMPLITUDE DISTRIBUTION EVALUATION OF A SEQUENCE OF RANDOMLY SPACED PULSES. Bertolaccini, M. (Politecnico, Milan); Bussolati, C.; Cova, S.; De Lotto, I.; Gatti, E. Nucl. Instrum. Methods, 61: 84-8(Apr. 15, 1968).

Starting from the theory of linear time invariant filters for optimum processing of the amplitude of single pulses, an ideal time variant system has been synthesized for the analysis of a sequence of random pulses and its performance has been evaluated. Demonstration is given that the system is the optimum one under the hypothesis of Gaussian noise and taking as criterion for the evaluation of amplitude resolution the rms deviation. (auth)

23372 TIMING UNIT FOR SEMICONDUCTOR SPECTROMETERS. Michaelis, W. (Kernforschungszentrum, Karlsruhe, Ger.). Nucl. Instrum. Methods, 61: 109-12(Apr. 15, 1968).

A timing unit is described which has been designed for semiconductor spectrometers where optimum energy resolution is of utmost importance. The circuit is connected between preamplifier and shaping amplifier. Leading edge timing is used for deriving the time signal. Results are shown for a charge-sensitive preamplifier with 150 nsec rise time. Employing a liquid scintillator and a planar 4.9 cm^3 Ge(Li) detector the full-width at half-maximum of the time distribution curve was 6.2 nsec if the semiconductor detector was gated on the 1836 keV full-energy peak from an ^{88}Y gamma-ray source. The circuit has been applied successfully in various high-resolution coincidence experiments. No energy resolution degradation has been observed. (auth)

23373 CYLINDRICAL CAPACITOR AS AN ANALYZER. II. RELATIVISTIC PART. Sar-El, H. Z. (Israel Atomic Energy Commission, Yavne). Rev. Sci. Instrum., 39: 533-40(Apr. 1968).

The study of the dynamic and optical properties of the cylindrical capacitor as an analyzer for charged particles is extended to the relativistic region. The proposed analyzer is found to be absolutely unrestricted by the relativistic effect, the latter introducing some changes which do not however impair the analytical features of the device. The emission angle for which there is a second order focus is energy-dependent, shifting from $\theta_0 = 42°18.5'$ in the nonrelativistic case to $\theta_0 = 55°$ in the ultrarelativistic case. It is shown that the usual derivation of the relativistic formulae from the nonrelativistic ones by replacing the nonrelativistic potential difference by an effective relativistic potential difference is incorrect for electrostatic devices, unless this quantity is given a specifically electrostatic form, distinct from the magnetic one. The figures of merit of the analyzer concerning resolution and luminosity are comparable with those of the best magnetic spectrometers. The analyzer seems to be simpler and cheaper than the magnetic type, but calls for very high deflecting voltages, which may be a disadvantage in operation. (auth)

23374 NQR SPECTROMETER USING FIELD EFFECT TRANSISTORS. Viswanathan, T. Lakshmi; (Indian Inst. of Tech., Kanpur); Viswanathan, T. R.; Sane, K. V. Rev. Sci. Instrum., 39: 472-5(Apr. 1968).

The advantages of using field-effect transistors (FET) for NQR spectrometer design are discussed. An experimental method of evaluating the performance of different oscillator configurations and optimizing the circuit parameters for best sensitivity is outlined. An NQR spectrometer system is described. (auth)

23375 CROSSED FIELD VELOCITY SELECTOR. Ogilvie, K. W. (Goddard Space Flight Center, Greenbelt, Md.); Kittredge, R. I.; Wilkerson, T. D. Rev. Sci. Instrum., 39: 459-65(Apr. 1968).

The paths of particles passing through crossed fields are calculated, with special application to the case where the particle does not complete a cycloidal oscillation. The use of such crossed fields in velocity selectors for space flight and in the laboratory is discussed. Curves are given which help in the choice of parameters for such applications. (auth)

23376 ON-BOARD PLASMA DATA PROCESSOR. Schaeffer, David H.; Snively, James W. Jr. (Goddard Space Flight Center, Greenbelt, Md.). Rev. Sci. Instrum., 39: 452-8(Apr. 1968).

A computing device that calculates quantities related to the mean, variance, and mode of the distribution of plasma as a function of the azimuthal angle of the spin stabilized satellite is aboard Explorer XXXIV. The device uses a combination of integrated circuits and discrete components including tunnel diodes. Performing computations aboard the spacecraft and telemetering the results of the calculations permits important features of the data to be sent using about one-twentieth of the number of information bits that would be required to transmit histograms of the collected data. (auth)

23377 MASS-ENERGY SPECTROMETER FOR SPACE PLASMAS. Ogilvie, K. W. (Goddard Space Flight Center, Greenbelt, Md.); McIlwraith, N.; Wilkerson, T. D. Rev. Sci. Instrum., 39: 441-51(Apr. 1968).

A satellite-borne instrument for the study of the interplanetary medium is described in detail. This plasma experiment illustrates a whole class of such measurements that can now be done on small unmanned scientific satellites. Plasma ions are resolved in both energy and mass per unit charge in order to determine hydrogen–helium abundance ratio, ion temperatures in the solar wind and transition region, and the angular distributions and fluctuations of ion flux. Protons and alpha particles with energy per unit charge between 300 and 5000 eV are resolved to better than 5 in 10^3 and their energy spectrum determined. Instead of current measurements, we employ single ion counting with an efficiency of 75% at rates up to 3×10^7 sec^{-1}. A histogram of counts against angular rotation is formed with a quantization of 23° and its area, variance and the azimuthal position of the peak derived by a small computer for transmission to the earth over a data link with a capacity of approximately 6 bits sec^{-1}. Provision is made for a preliminary study of variations in the ion flux with periods greater than a few seconds. (auth)

23378 FIELD EFFECT TRANSISTORS AT 4.2°K. Kingston, Floyd E.; Lee, Kenneth (Varian Associates, Palo Alto, Calif.). Rev. Sci. Instrum., 39: 599-601(Apr. 1968).

The amplification characteristics of MOSFET amplifiers at room temperature, 77°K, and 4.2°K are investigated. An rf oscillator and low-noise preamplifier were constructed using MOSFET amplifiers and tested at 4.2°K. The operation and performance are discussed. (W.H.K.)

23379 CONTINUOUS AVERAGING OF X-RAY DIFFRACTION DATA USING A MULTICHANNEL ANALYZER. Weymouth, John W.; Costello, James; Schuster, Sanford; Schulze, Paul (Univ. of Nebraska, Lincoln). Contract AT(11-1)-525. Rev. Sci. Instrum., 39: 476-7(Apr. 1968). (COO-525-22).

A continuously averaging system is described in which a multichannel analyzer is coupled to an x-ray diffractometer. The motion of the arm of the diffractometer is synchronized with the channel advance so that there is a 1 to 1 correspondence between 2θ increments and channels. With this system a weak x-ray diffraction signal may be scanned repeatedly and the signal built up against the random noise introduced by fluctuations in the generating and detecting system with periods long compared to the channel dwell time. Other convenient uses of the analyzer in handling the x-ray diffraction data are briefly mentioned. (auth)

23380 WHOLE-BODY NMR SPECTROMETER. Jackson, Jasper A.; Langham, Wright H. (Los Alamos Scientific Lab., N. Mex.). Contract W-7405-eng-36. Rev. Sci. Instrum., 39: 510-13(Apr. 1968). (LA-DC-8734).

A low-frequency NMR spectrometer has been built that will accommodate sample volumes of 0.2 and 1.25 liters. A shielded solenoid provides a uniform field of about 10 G. Signals are detected by a symmetrical rf bridge whose coils are bank wound of litz wire with Q ~ 300 to 400 at 40 kHz. In the smaller coil the homogeneity is sufficient to distinguish signals of protons in protein from those in fat and water. Spectra have been obtained from gelatin, whole eggs, egg whites, egg yolks, and dead mice. In addition, what is believed to be the first NMR signal ever obtained from a whole living animal has been taken on an anesthetized rat. (auth)

23381 SIMPLE NMR PROBE FOR USE IN SUPERCONDUCTING SOLENOIDS. Higgins, R. J.; Chang, Yung Kwang (Univ. of Oregon, Eugene). Rev. Sci. Instrum., 39: 522-3(Apr. 1968).

A simple nuclear magnetic resonance probe, for field calibration use over the 10–50 kG magnetic field range in superconducting solenoids at liquid helium temperature, is described. The probe uses the ^{27}Al resonance from aluminum powder, and is attached without electronic modification to a commercial NMR (marginal oscillator) gaussmeter. (auth)

23382 NUCLEAR QUADRUPOLE RESONANCE THERMOMETRY. Utton, D. B. (National Bureau of Standards, Washington, D. C.). Metrologia, 3: 98-105(Oct. 1967).

The nuclear quadrupole resonance (nqr) frequency of ^{35}Cl in $KClO_3$ was studied in the temperature range 12°K to 297°K. The combined uncertainties in the frequency and temperature measurements corresponded to ±0.001°K in the range 50°K to 297°K, deteriorating to ±0.004°K at 30°K and ±0.010°K at 20°K. Both the nuclear resonance spectrometer and the temperature control apparatus are described. The experimental data were fitted to a theoretical expression in the temperature range 12°K to 90°K; at higher temperature the data were fitted to empirical polynomials. It is concluded that measurement of the nqr frequency of ^{35}Cl in $KClO_3$ is a practical thermometric technique which is capable of an experimental precision to at least ±1 millidegree down to a temperature of 50°K. This precision, accomplished in the present investigation, could be increased, for example, by lengthening the measurement time (at present 20 sec). While the upper temperature limit for this substance has not been determined, it is at least 473°K; it melts at 641°K. (BBB)

23383 COMPUTER IMPLEMENTATION OF THE ADDED-STEP DIFFERENTIAL LINEARIZATION TECHNIQUE. Waugh, J. B. S. (Univ. of Rochester, N. Y.). Nucl. Instrum. Methods, 61: 121(Apr. 15, 1968).

The added-step differential linearization technique can be simply implemented on computer interfaced ADC's. A minimum of additional hardware and only a short program are required. (auth)

23384 MESUCORA 67: CONGRES INTERNATIONAL, PARIS DU 17 AU 21 AVRIL 1967. (MESUCORA 67: International Congress, Paris, April 17–21, 1967). Paris, Association MESUCORA, 1967. 980p. (CONF-670438).

Eighty-nine papers discuss methods of measurement including measurement of temperature, connection of sensors with data processing systems, high precision measurement and measurement in very extreme environmental conditions, reliability of electronic instruments, various measurement and industrial control, chemical analysis by physical methods, measurement in relation with very high currents, measuring sensors, and measurement of mechanical and dimensional quantities. The discussions following each paper are compiled. (J.S.R.)

23385 OPTICAL DEVICE FOR THE DETERMINATION OF THE SYMMETRY AND SURFACE CONDITIONS OF THE INSIDE OF TUBES. Krischer, Wolfgang (to European Atomic Energy Community). British Patent 1,108,235. Apr. 3, 1968. Priority date Nov. 10, 1964, Belgium.

The instrument consists of means for directing obliquely onto the interior of the tube either a narrow ring of light or a spot of light which scans a ring around the interior of the tube, an apertured diaphragm for receiving light reflected from the tube, and micrometer means for adjusting the aperture position to lie in the path of the reflected light. (W.H.K.)

23386 DEVICE FOR CONTROLLING INSTRUMENTS AT HIGH VOLTAGE WITH LIGHT. Toi, Atsutomo (to Matsushita Electric Industries Co., Ltd.). Japanese Patent 1966-18400. Oct. 21, 1966. Filed Nov. 2, 1963.

The proposed device for controlling instruments at high voltage, such as an electron or ion source for the Van de Graaff accelerator, is capable of giving precise control-signals by means of light. The advantages to the device include easy operation, and there is no need for shaping the wave form. A Braun tube or other tube, which emits light by electron rays, is used for pro-

ducing and transmitting light. Thus, the electrical signal for instrument control is converted into light, which is then transmitted to the high-voltage place by means of transparent insulating glass-fiber. There the light is converted back into an electrical signal for instrument control. (NSA of Japan)

23387 ELECTROMAGNETIC FLOWMETER. Schwab, Bernard (to Commissariat a l'Energie Atomique). British Patent 1,108,149. Apr. 3, 1968. Priority date Mar. 22, 1966, France.

An electromagnetic flowmeter which operates in a similar way to a shunt excitation generator is described. The flowmeter is used to measure the rate of flow of liquid sodium. (W.H.K.)

23388 THE PHYSICS EXHIBITION, 1968, LONDON, 11–14 MARCH 1968. 52ND Exhibition of Scientific Instruments and Apparatus. London, Institute of Physics and Physical Society, 1968. 304p.

Generalized descriptions are presented of the scientific apparatus and instruments exhibited at the 1968 Physics Exhibition at Alexandra Palace, London, during March 11-14, 1968. Indexes of exhibitors and exhibits are provided. (B.G.D.)

23389 PNEUMATIC EXTENSOMETER, ESPECIALLY FOR A CREEP MEASURING CELL. Bret, Antoine; Mennesson, Robert; Quidu, Robert (to Commissariat a l'Energie Atomique). British Patent 1,106,888. Mar. 20, 1968. Priority date July 23, 1965, France.

A pneumatic extensometer, designed especially for taking creep measurements on test pieces which are placed in a nuclear reactor and subjected to high temperature and to neutron radiation, is described. (W.H.K.)

23390 IMPROVEMENTS IN OR RELATING TO RADIOACTIVE LIGHTNING RODS. (to General Protection Establishment). British Patent 1,106,699. Mar. 20, 1968. Priority date Mar. 12, 1965, Switzerland.

The design of a radioactive lightning rod composed of a grounded rod and at least one radioactive ionizing source consisting of americium-241 or one of its oxides is presented. (W.H.K.)

23391 COUPLED-INDUCTANCE LEVEL INDICATOR FOR LIQUID METALS. Cambillari, Etienne; le Frere, Jean Paul; Lelong, Jacques; Morisset, Roger (to Commissariat a l'Energie Atomique). British Patent 1,106,730. Mar. 20, 1968. Priority date Nov. 4, 1965, France.

A feedback amplifier system is described that compensates for temperature variations in a coupled-inductance level indicator for liquid metals. An impedance bridge with a reference voltage source is used to keep the level indicator calibrated. (W.H.K.)

23392 IMPROVEMENTS IN SAFETY DEVICES OF THE COMPARISON TYPE. (to Compagnie Francaise Thomson Houston-Hotchkiss Brandt). British Patent 1,105,369. Mar. 6, 1968. Priority date Dec. 23, 1964, France.

A discrepancy device that compares three analog signals and indicates if one of these signals is different from the others is described. The threshold reference voltage applied to the threshold triggers is proportional to the mean value of the signals to be compared. (W.H.K.)

Radiation Effects on Instruments and Instrument Components

Refer also to abstract 24491.

23393 SELECTIVE ELECTRON-BEAM IRRADIATION OF METAL-OXIDE-SEMICONDUCTOR STRUCTURES. MacDonald, N. C.; Everhart, T. E. (Univ. of California, Berkeley). J. Appl. Phys., 39: 2433-47(Apr. 1968).

Both transient and steady-state changes in the electrical characteristics of metal–oxide–semiconductor transistors (MOST's) produced by localized electron-beam bombardment are reported. Typically, areas $10\,\mu \times 10\,\mu$ were bombarded on the gate of the MOST by scanning a 0.1-μ diameter electron beam over this area. The electron-beam energy was variable from 5 to 30 keV, the beam current was varied from 1 to 1000 pA, and the time to scan one frame was typically 8 msec. During bombardment with positive gate voltage V_{GB}, the negative charge in the MOST channel induced by bombardment, Q_s', was found to increase, which implies that a fixed positive charge Q_{SB} builds up in the oxide during bombardment. Q_s' reached a steady-state or saturated value, $Q_s'(sat)$, after a total primary electron-beam bombardment of approximately 10^{-4} C/cm^2. A linear relationship between $Q_s'(sat)$ and the gate voltage during bombardment V_{GB} was observed for both n-channel and p-channel devices, for $0 < V_{GB} \lesssim 3.6$ V. This linear relationship is consistent with a fixed distance x_1 between the mean position of the oxide charge Q_{SB} and the semiconductor-oxide interface. Values of x_1 ranging from 45 to 65 Å were calculated from measurements on p-channel devices, and $x_1 = 75$ Å was calculated from measurements on n-channel devices. For $V_{GB} \gtrsim 3.6$ V, the $Q_s'(sat)$ vs V_{GB} curve abruptly leveled off; this effect may be explained by electron tunneling from the semiconductor into the conduction band of the oxide. Transient measurements during bombardment with $V_{GB} > 0$ showed that Q_s' and the gate current which flowed during bombardment i_{GB} had an exponential time dependence, with the same time constant. This time constant τ_c was independent of V_{GB}, but varied with electron-beam voltage and current. The positive oxide charge Q_{SB} could be neutralized by bombarding the device with $V_{GB} < 0$. The discharge time constant τ_d was always less than the charging time constant τ_c and τ_d was a function of V_{GB} as well as the electron-beam voltage and current. Controlled temperature measurements showed that the oxides of the devices used for these electron-bombardment experiments were free of mobile ions, that no neutralization of Q_{SB} occurred in devices heated to 150°C for several hr, but partial neutralization of Q_{SB} occurred after heating at higher temperatures. The experimental results were remarkably reproducible for several trials on one device, as well as from device to device. The steady-state experimental results are explained by a constant density of traps/unit energy, K_t, which exists in the oxide near the oxide–semiconductor interface. During bombardment with $V_{GB} > 0$, these traps become charged, such that the steady-state oxide charge density decreases exponentially away from the oxide–semiconductor interface with characteristic length $x_1 = [\epsilon_{ox}/q^2K_t]^{\frac{1}{2}}$. The transient charging of the oxide is analyzed using a sheet-charge analysis. An additional measurable parameter results from the transient analysis, the charging time constant τ_c. All dependences of Q_s' and oxide charging current predicted by the analysis are observed experimentally. (auth)

23394 CHARACTERISTICS OF THERMAL ANNEALING OF RADIATION DAMAGE IN MOSFET'S. Danchenko, Vitaly (Goddard Space Flight Center, Greenbelt, Md.); Desai, Upendra D.; Brashears, Sidney S. J. Appl. Phys., 39: 2417-24(Apr. 1968).

The thermal annealing characteristics of radiation damage in p-channel MOSFET's due to irradiation by 1.5 MeV electrons as a function of time and temperature are presented. Both isothermal and isochronal annealing curves are analyzed and it is found that the activation energy of the annealing processes has a distribution in a range of 1 eV with the peak at about 1 eV. The mechanism of radiation damage and the model of thermal annealing in the MOSFET's are discussed. (auth)

LIFE SCIENCES

Biochemistry, Physiology, and Molecular Biology

Refer also to abstracts 23245, 23246, 23486, 23502, 23615–23617, 23623, 23639, 23642, 23672, 23674, 23686, 23692, and 23694.

23395 (COO–1285–11) TECHNICAL PROGRESS REPORT [ON BLOOD]. (Evanston Hospital, Ill.). [1968]. Contract AT(11-1)-1285. 7p. Dep. CFSTI.

Endotoxin, lipopolysaccharide (L.P.S.), labeled with ^{32}P was prepared from human blood group B specific Escherichia coli. The interaction of L.P.S. with human erythrocytes was studied. The minimal amount of ^{32}P-L.P.S. fixed per red cell allowing detectable agglutination under standard conditions by human anti-blood-group B serum and that amount just permitting maximal agglutination was determined as well as the maximal uptake per red cell. As few as 6.6×10^{-10} micrograms per erythrocyte sufficed to render the erythrocytes agglutinable by human anti-B serum. Much larger amounts could be fixed per cell, however, without increase in hemagglutination titer. Glycolipids, aliphatic carbonyls, lipoproteins, globin, and L.P.S.-receptor inhibited toxin fixation onto red cells as measured by erythrocyte uptake of ^{32}P-L.P.S. Blood group specific Escherichia coli were fed to infants and adults. The results showed that ingestion of E. coli stimulated de novo isohemolysin and isoagglutinin formation in infants and increased pre-existing levels in adults. (H.L.W.)

23396 (COO–1495–6) MOVEMENT OF STRONTIUM THROUGH THE SOIL TO PLANT ROOT MEMBRANES. Technical Progress Report, June 1, 1967–May 31, 1968. (Purdue Univ., Lafayette, Ind.). Feb. 16, 1968. Contract AT(11-1)-1495. 47p. Dep. CFSTI.

ROOTS—absorption of calcium and strontium from soil by, of lettuce, soybeans, tomatoes, and wheat

SOILS—distribution of calcium and strontium between liquid and solid phases of, effects of soil properties on

23397 (COO–1704–4) CORRELATION BETWEEN RADIATION AND CHEMICAL INDUCED MOLECULAR DAMAGES AND THEIR BIOLOGICAL EXPRESSION IN MAMMALIAN CELLS. Annual Progress Report, June 1, 1967–June 1, 1968. Trosko, James E. (Michigan State Univ., East Lansing. Dept. of Natural Science). Contract AT(11-1)-1704. 7p. Dep. CFSTI.

Photoreactivation repair mechanisms were studied in Chinese hamster cells. No excision or monomerization of pyrimidine dimers were detected. Studies on caffeine sensitization of uv damage showed that DNA synthesis in uv-irradiated hamster cells was not affected by caffeine. Techniques are being developed for examining the molecular effects of uv on DNA structure, synthesis, and degradation in mammalian cells. Attempts were made to study effects of uv irradiation on isolated mammalian chromosomes. Nuclease induction by chromosome-breaking agents was investigated. Studies were begun on the effects of uv radiation on Drosophila. When cultured cells of tobacco (Nicotiana tabacum) and Haplopappus gracilis were irradiated with uv, thymine-containing dimers were formed in large quantities. Experiments on the effects of platinum salts on cell division were conducted; no inhibition of mitosis was observed. (H.L.W.)

23398 (IA–1128, pp 147–55) BIOLOGY AND MEDICINE. (Israel Atomic Energy Commission, Tel Aviv).

Medical research is being conducted at the Radioisotope Center operated jointly with the Negev Central Hospital at Beersheba. Studies were carried out on the detection of radiation exposure by fluorescent microscopy of human blood cells. Human blood smears stained with acridine orange showed a fixed ratio of doubly colored leukocytes to red colored leucokytes. The ratio decreased in persons exposed to x rays. Hospital personnel and patients exposed to x radiodiagnosis were used as subjects. It was found that the number of doubly colored cells decreased and the number of red colored cells increased following exposure, and the effect increased with increasing doses. Other studies were conducted on the mechanism of formation of thymine dimers in uv-irradiated DNA. Effects of ultraviolet radiation on frozen thymine and on thymine in solution were investigated. Formation of thymine dimers was greatly reduced in dry DNA. Reduction of dimer formation was also observed in uv-irradiated bacterial spores. It was demonstrated that copper ions enhanced the radiolytic decomposition of diamines and amino acids. It was shown that copper ions were the only cations that enhanced the radiolytic deactivation of rabbit muscle enolase and bovine pancreatic ribonuclease. Experiments with Bacillus cereus showed that γ-radiosensitivity was enhanced when the bacteria were grown in a medium containing cupric ions. (H.L.W.)

23399 (IA–1128, pp 213–19) PRODUCTION OF RADIOISOTOPES AND LABELLED PHARMACEUTICALS. (Israel Atomic Energy Commission, Tel Aviv).

A new unit was put into operation for the routine production of ^{131}I by irradiating tellurium. Improvements were made in the production of carrier-free ^{43}K from reactor irradiation of ^{43}Ca. Further work was carried out on the development of a generator for ^{99}Tc. Methods of preparing ^{131}I-labeled triolein and oleic acid, a new method for preparing ^{131}I-labeled hippuran based on isotopic exchange, and an improved method for the preparation of ^{131}I-labeled Rose Bengal are described. Methods for the preparation of ^{131}I-labeled serum albumin and albumin macroaggregates are discussed. (H.L.W.)

23400 (LF–38) FISSION PRODUCT INHALATION PROGRAM ANNUAL REPORT, 1966–1967. McClellan, R. O.; Rupprecht, F. C. (eds.) (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.). Nov. 1967. Contract AT(29-2)-1013. 168p. Dep. CFSTI.

Separate abstracts were prepared on 19 sections of this report discussing the toxic effects of radioisotope inhalation on beagle dogs. Research on the metabolism and distribution of inhaled radioisotopes as well as the effects on various organs is described. (C.H.)

For abstracts of individual sections see: 23245, 23246, 23401–23407, 23486, 23505, 23594–23596, and 25215–25219.

23401 (LF–38, pp 1–18) TOXICITY OF INHALED ^{90}Sr IN BEAGLE DOGS. (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.).

To aid in assessing the biological consequences of inhaling ^{90}Sr, such as might be released in certain nuclear accidents, studies on the metabolism, dosimetry, and effects of inhaled $^{90}SrCl_2$ were conducted in beagle dogs. Seventy dogs were exposed to aerosols containing ^{90}Sr, resulting in initial body burdens ranging from 2.6 to 280 μCi/kg. Forty-six of these dogs will be maintained for lifetime observation. To date, five animals have died or were euthanized; four had high initial body burdens during the first 31 days after exposure and developed severe hematologic dyscrasia; and one examined at 585 days after exposure had developed leukemia. Serial observations were continued on all surviving animals with special emphasis on evaluating ^{90}Sr metabolism and dosimetry, and clinical, microbiologic, serum chemistry, and hematologic parameters. (C.H.)

23402 (LF–38, pp 19–39) THE TOXICITY OF INHALED $^{144}CeCl_3$ IN BEAGLE DOGS. (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.).

To aid in assessing the biological consequences of inhaling ^{144}Ce, such as might be released in certain nuclear accidents, studies on the metabolism, dosimetry, and effects of inhaled $^{144}CeCl_3$ were conducted in beagle dogs. Seventy dogs were exposed to aerosols containing ^{144}Ce, resulting in initial body burdens ranging from 2 to 700 μCi/kg. Twenty-seven dogs with low body burdens were observed by whole-body counting, periodic collection of excreta, and serial sacrifice at 0 to 512 days after exposure to aid in evaluating the metabolism and dosimetry of inhaled $^{144}CeCl_3$. Forty-two longevity dogs were placed in four groups based on their initial body burdens (group means of 13, 37, 137 and 460 μCi/kg). They were also regrouped based on the body burden of ^{144}Ce retained at 14 days post-exposure, yielding groups with mean 14-day values of 5.4, 14, 43, and 200 μCi/kg. One additional dog was maintained as an extra. Four dogs from the highest dose-group euthanized at 21 to 31 days post-exposure showed symptoms attributed to severe bone-marrow damage with associated pancytopenia. The remaining two dogs from the highest dose-group died at 138 and 144 days after exposure with death attributed in part to pulmonary infection. An additional group of dogs was exposed with an initial ^{144}Ce body burden of 300 μCi/kg (14-day post-exposure burden of 125 μCi/kg). Serial observations were continued on all surviving animals with special emphasis on evaluating ^{144}Ce metabolism, dosimetry, clinical, microbiologic, serum chemistry, and hematologic parameters. (auth)

23403 (LF–38, pp 40–64) TOXICITY OF INHALED $^{91}YCl_3$ IN BEAGLE DOGS. (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.).

To aid in assessing the biological consequences of inhaling ^{91}Y, such as might be released in certain nuclear accidents, studies on the metabolism, dosimetry, and effects of inhaled $^{91}YCl_3$ were conducted in beagle dogs. Seventy-three dogs were exposed to aerosols containing ^{91}Y, resulting in initial body burdens that range from 0.30 to 1340 μCi/kg. Twenty-seven dogs with initial body burdens of 0.30 to 0.85 μCi/kg were followed by whole-body counting, periodic collection of excreta, and serial sacrifice at 0 to 128 days after exposure to aid in evaluating the metabolism and dosimetry of inhaled $^{91}YCl_3$. Forty-two dogs were arranged in four longevity groups based on their initial ^{91}Y body burdens. This yielded groups with mean initial body burdens of 120, 260, 560 and 920 μCi/kg. For comparison with observed biological effects, these same dogs were regrouped according to their retained 14-day body burdens yielding groups with mean 14-day values of 31, 59, 140 and 270 μCi/kg. These dogs were maintained for lifetime observation. Four dogs with a mean initial body burden of 560 μCi ^{91}Y/kg and a mean 14-day body burden of 150 μCi ^{91}Y/kg were placed in a sacrifice series. Eleven dogs with 14-day body burdens ranging from 150 to 510 μCi ^{91}Y/kg that died or were euthanized at 17 to 33 days post-exposure showed a severe hematologic dyscrasia. Serial observations are continuing on all survivors with special emphasis on evaluating ^{91}Y metabolism and dosimetry and various clinical, microbiologic, serum chemical and hematologic parameters. (auth)

23404 (LF-38, pp 65-72) TOXICITY OF INHALED ^{90}Sr IN RATS. (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.).

Rats were exposed to aerosols containing tracer levels of ^{85}Sr and ^{90}Sr or toxic levels of ^{90}Sr resulting in initial body burdens up to 1600 μCi ^{90}Sr/kg. Effective half-time of retention of ^{90}Sr in bone was approximately 600 days, calculated on the basis of ^{90}Sr-concentration in femur. Osteosarcoma was present in about 50% of the animals. At any time post-exposure, those animals in which osteosarcomas were found had received a higher average daily Rad-dose to bone than those without bone tumors. Life-span shortening appeared to be twice as great for an increase of about three in average daily Rad-dose to bone. (auth)

23405 (LF-38, pp 79-87) TOXICITY OF HIGH DOSES OF ^{90}Sr AND ^{137}Cs INJECTED INTO RATS. (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.).

The toxic behavior of ^{137}Cs and ^{90}Sr, singly and in various combinations, was studied following intraperitoneal injection into rats. Whole-body retention of ^{90}Sr was greater in animals that died within 30 days post-exposure; the retention of high levels of ^{137}Cs showed an opposite pattern. Survival data indicate some synergistic action between the two radionuclides. (auth)

23406 (LF-38, pp 88-91) CANINE EXPOSURE APPARATUS PERMITTING USE OF HIGH-LEVEL RADIOACTIVE AEROSOLS. (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.).

The design and construction of an improved dog-exposure apparatus and a dry-box assembly for isotope preparations are described. The dry-box assembly is equipped with manipulators for remote handling of aerosol generators containing high levels of activity. With the manipulators, the generator may be inserted into a lead shield equipped with wheels and mounted on a track in the dry-box. The lead shield with generator may be moved directly into a mobile transfer box that is sealed for movement to the exposure apparatus. The lead shield with generator may then be moved directly from the transfer box into the exposure apparatus under sealed conditions. This system permitted the exposure of beagle dogs to aerosol concentrations of ^{90}Sr or ^{144}Ce as high as 650 μCi/liter of air. (auth)

23407 (LF-38, pp 147-52) GENERAL PURPOSE INFORMATION PROCESSING AND RETRIEVAL SYSTEM FOR BIOMEDICAL DATA. (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.).

An integrated programming system (SYS1013) is under development which is primarily designed to facilitate the processing and retrieval of multi-disciplinary information originating from a long-term radioisotope toxicity program. Upon completion, the system will permit the investigator(s) to retrieve and manipulate all available experimental data (of multi-disciplined origin) on a given experimental animal or groups of experimental animals. More specifically, the basic functions of SYS1013, which facilitate the integration of experimental data, are to store, update, and retrieve data; select, sort, correlate, and list data for analysis; automate general statistical analysis techniques; and summarize data through standard reporting procedures. (auth)

23408 (NYO-2735-8) CHEMICAL EFFECTS OF IONIZING RADIATIONS ON THE INDIVIDUAL AMINO ACIDS WITHIN INTACT AND PURE PROTEIN MOLECULES. Annual Progress Report 1967–1968. Friedberg, Felix (Howard Univ., Washington, D. C. Dept. of Biochemistry). Nov. 30, 1967. Contract AT(30-1)-2735. 6p. Dep. CFSTI.

Progress is reported in studies on the effects of γ radiation on the induction of changes in the molecular weight of individual amino acids within intact and pure protein molecules. Exposure of native ribonuclease or lysozyme in the dry state in vacuo to γ radiation caused formation of higher molecular-weight components of the protein molecules but no evidence of degradation of protein molecules was observed. Exposure of alkylated form of ribonuclease or lysozyme to γ radiation caused formation of smaller molecular-weight components of the protein molecules. (C.H.)

23409 (NYO-2798-32) PROGRESS REPORT [ON EFFECTS OF ULTRAVIOLET RADIATION ON NUCLEIC ACIDS AND RELATED COMPOUNDS], DECEMBER 1, 1964–NOVEMBER 31, 1967. Wang, Shih Yi (Johns Hopkins Univ., Baltimore, Md. Dept. of Biochemistry). Sept. 1967. Contract AT(30-1)-2798. 18p. Dep. CFSTI.

NUCLEIC ACID, DEOXYRIBO-, —radioinduced formation of cyclobutyl dimers and thymine photoproducts in, uv
PYRIMIDINES—photochemical reactions in, mechanisms of
URACIL, 5-BROMO-, —photochemistry of derivatives of, in aqueous solution
THYMINE—photochemistry of derivatives of, in aqueous solution
ULTRAVIOLET RADIATION—induced formation of cyclobutyl dimers and thymine photoproducts in DNA (H.L.W.)

23410 (NYO-3319-17) FACTORS INFLUENCING RADIORESISTANCE OF MICROORGANISMS. Technical Progress Report, January 1–September 15, 1967. Bruce, Alan K. (State Univ. of New York, Buffalo. Dept. of Biology). Contract AT(30-1)-3319. 25p. Dep. CFSTI.

BENZOIC ACID, P-(HYDROXYMERCURI)-, —binding by Escherichia coli and Micrococcus radiodurans
SCHIZOMYCOTA—Micrococcus radiodurans, radiosensitive mutants of, isolation of; Micrococcus radiodurans, radiation effects on binding of p-hydroxymercuribenzoate by, x; Sarcina lutea, radiation effects on binding of p-hydroxymercuribenzoate to, x; Escherichia coli, radiation effects on binding of p-hydroxymercuribenzoate to, x
ULTRAVIOLET RADIATION—effects on Micrococcus radiodurans, mutagenic; effects on growth cycle of Micrococcus radiodurans
GUANIDINE, 1-METHYL,3-NITRO,1-NITROSO—effects on Micrococcus radiodurans, mutagenic
ANTIBIOTICS—sensitivity of Micrococcus radiodurans to
X RADIATION—effects on p-hydroxymercuribenzoate, toxic effects of, on Micrococcus radiodurans; effects on growth cycle of Micrococcus radiodurans
PROTEINS—binding of p-hydroxymercuribenzoate by, of Micrococcus radiodurans (H.L.W.)

23411 (NYO-3641-2) RADIATION CHEMISTRY AND RADIOBIOLOGY OF MEDIUM EFFECTS. Progress Report for Period January 1, 1967–November 30, 1967. (Pittsburgh Univ., Pa. Dept. of Occupational Health). Nov. 30, 1967. Contract AT(30-1)-3641. 81p. Dep. CFSTI.

CULTURE MEDIA—radiation effects on biological and chemical properties of, γ
SUCROSE—radioinduced formation of glyoxal and glyoxylic acid in solutions of, effects of hydrogen peroxide on γ
SCHIZOMYCOTA—Salmonella typhimurium, radiation effects on growth of, effects of hydrogen peroxide and oxygen on γ

23412 (NYO-3924-1) INCORPORATION OF ^{125}I-LABELED 5-IODO-2'-DEOXYURIDINE INTO THE DNA OF MOUSE MAMMARY TUMORS. Dethlefsen, Lyle A. (Pennsylvania Univ., Philadelphia. Dept. of Radiology). Feb. 25, 1968. Contract AT(30-1)-3924. 34p. (CONF-680206-1). Dep. CFSTI.

From Symposium on Normal and Malignant Cell Growth, Chicago, Ill.

The metabolism of DNA in mammary tumors in mice was studied, with emphasis on the use of ^{125}I-5-iodo-2'-deoxyuridine (^{125}I-IUdR) as a tracer for external counting of tumor radioactivity as an index of DNA accumulation. It was concluded that external measurements of radiation following the injection of ^{125}I-IUdR were a reliable index for the rate of DNA accumulation. The simultaneous use of volumetric methods and autoradiography permitted additional insight into the biology of solid tumors. (C.H.)

23413 (ORO-3547-6) ROLE AND UTILIZATION OF ERYTHROPOIETIN IN STIMULATING ERYTHROPOIESIS. Progress Report. [Lange, Robert D.; McDonald, T. P.] (Tennessee Univ.,

Knoxville). Feb. 27, 1968. Contract AT(40-1)-3547. 6p. Dep. CFSTI.

Antiserum to erythropoietin, produced in rabbits, was labeled with fluorescein for use in studies on erythroid spleen colonies of irradiated mice with bone marrow transplants. The spleen colony technique was used to determine effects of erythropoietin on stem cell differentiation. Experiments were conducted on the effects of x radiation, bone marrow transplantation, and hypoxia on production of erythropoietin in mice. Irradiation had little effect on erythropoietin levels until eight days after irradiation when the level became elevated. In experiments in which mice were exposed to both hypoxia and x radiation, distinct cyclic elevations of erythropoietin levels were observed. After irradiation and bone marrow transplantation, slight elevations of erythropoietin were obtained. Levels of erythropoietin were measured in functioning and hypo-functioning bone marrow suspension cultures. Determinations of hematocrit values, reticulocyte counts, red blood cell ^{59}Fe incorporations, and responses to erythropoietin were made on polycythemic mice. Mice were exposed to hypoxia by enclosure in silicone rubber membrane cages. They consumed less food and water during the period of enclosure and lost from 5 to 10% of their starting weight. The blood volume and red cell mass, as measured by ^{51}Cr methods, increased during the enclosure period, while the plasma volume showed little change. Testosterone and erythropoietin were added to rabbit bone marrow suspension cultures. The results indicated that testosterone alone was ineffective in stimulating erythropoiesis, while erythropoietin alone increased cellular ^{59}Fe incorporation; the two hormones together, however, increased the ^{59}Fe incorporation to a greater extent than erythropoietin alone. A hemagglutination system was developed for detecting and quantitating erythropoietin in normal human serum. Effects of erythropoietin on the prevention of secondary disease in mice were studied. (H.L.W.)

23414 (ORO-3599-1) VISUAL CELLULAR STIMULATION BY HIGH ENERGY QUANTA. Technical Progress Report, December 1, 1966–September 1, 1967. Dawson, William W. (Florida Univ., Gainesville. Coll. of Medicine). Contract AT(40-1)-3599. 15p. Dep. CFSTI.

X RADIATION — effects on light response of cells of retina rabbit

RABBITS — transduction of x ray quanta into information transmitted by optic nerve in, identification of cells in retina responsible for (E.R.B.)

23415 (SAN-733-1) EFFECT OF CONTINUOUS GAMMA IRRADIATION ON GROWTH OF VIRUSES IN TISSUE CULTURE SYSTEMS. Progress Report, May 15, 1967–May 14, 1968. Quilligan, J. J. Jr. (Loma Linda Univ., Los Angeles, Calif.). Feb. 12, 1968. Contract AT(04-3)-733. 15p. Dep. CFSTI.

It was possible to demonstrate that ^{60}Co γ irradiation in proper dose and time sequence could enhance the growth of myxoviruses in tissue culture systems. The virus used was an A_2 isolate obtained in 1966 in our laboratory. A clear and precise relationship was observed between numbers of hemadsorption plaques and irradiation dose. The action of interferon and other factors influencing virus growth can now be examined. A new method for β irradiation of tissue culture cells was developed utilizing as a $^{90}Sr-^{90}Y$ source of irradiation. Such a system lends itself to the problems of the effects of irradiation on the susceptibility of cells to virus infection. Gamma irradiation of cell mixtures in an attempt to develop hybrid forms with high virus growth potential were carried out. A series of experiments was designed to explore useful radiation doses that would allow for intimate mixing of separate cell lines. Attempts were made to develop a continuous cell line that would have characteristics of a hybrid nature derived from both cell lines. A large number of such combinations of cells were examined. The only mixture that gave any promise was chick embryonic lung and baby hamster kidney 21 cell lines. However, after three passages, only the irradiated BHK 21 and its nonirradiated control were still growing well four months later. It is now evident that irradiation of both cell lines is not desirable. Further tests will be conducted irradiating only one of the cell lines to be mixed. Whether irradiating the primary or continuous cell is the best approach must be determined in future experiments. (auth)

23416 (UCRL-17481) BIOLOGY AND MEDICINE. Semiannual Report, Spring 1967. Lawrence, John H. (ed.) (California Univ., Berkeley. Donner Lab. California Univ., Berkeley. Donner Pavilion). Contract W-7405-eng-48. 178p. Dep. CFSTI.

Separate abstracts were prepared for four papers in this report. Eleven other papers on various aspects of erythropoiesis are included. (H.L.W.)

For abstracts of individual papers see: 23417, 23418, 23598, and 23683.

23417 (UCRL-17481, pp 133-7) PULSED HIGH INTENSITY X RAYS: INACTIVATION OF HUMAN CELLS CULTURED IN VITRO AND LIMITATIONS ON USEFULNESS IN RADIOTHERAPY. Todd, Paul W.; Winchell, H. Saul; Feola, Jose M.; Jones, Gary E.

Pulse 10 MVp x rays administered at dose rates of 10^{11} to 10^{12} rads/sec and in the total dose range of 200 to 1050 rads/pulse did not differ significantly from ^{60}Co gamma rays in their ability to inactivate aerated cultured human cells. It is estimated that a total dose of 260,000 rads delivered at dose rates greater than 10^9 rads/sec is necessary to eliminate the oxygen effect in aerated cells. Assuming that a total single dose of 2000 rads is the maximum acceptable in therapeutic procedures, it is estimated that at dose rates greater than 10^8 rads/sec the partial pressure of oxygen in tissue would have to be reduced to less than 1.1 mm Hg prior to irradiation to eliminate the oxygen effect. (auth)

23418 (UCRL-17481, pp 145-53) EFFECT OF NEGATIVE PIONS ON THE PROLIFERATIVE CAPACITY OF ASCITES TUMOR CELLS (LYMPHOMA) GROWN IN VIVO. Feola, Jose M.; Richman, Chaim; Raju, Mudundi R.; Curtis, Stanley B.; Lawrence, John H.

Mice were injected intraperitoneally with lymphoma cells five days before beginning irradiation. Experiments were conducted on pion effects in vivo with environmental control, ^{60}Co effects in vivo with environmental control, pion effects in vivo without environmental control, and acute x irradiation in vivo. It was shown that the peak region of a pion beam was considerably more effective than an equivalent dose of γ rays in inhibiting the proliferative capacity of lymphoma cells in vivo. This result implies that there is a biologically significant component of high-LET radiation in the peak region of a pion beam. This in turn implies that the oxygen-enhancement ratio will be low, making the peak-region radiation of a pion beam more effective than conventional radiation in killing the anoxic cells found in tumors. It appears at present that negative pions have interesting possibilities in tumor radiotherapy. (H.L.W.)

23419 ENHANCED ERYTHROPOIESIS WITH CONCOMITANT DIMINISHED GRANULOPOIESIS IN PREIRRADIATED RECIPIENT MICE. EVIDENCE FOR A COMMON STEM CELL. Hellman, Samuel; Grate, Helen E. (Yale Univ., New Haven). J. Exp. Med., 127: 605-12(Mar. 1, 1968).

Three methods of measuring the proliferative capacity of transplanted mouse bone marrow were used to study the effects of preirradiation of the recipient. Recipient mice were exposed to 700 R and given graded numbers of syngeneic bone marrow. Seven days were allowed for proliferation of these cells, and then the granulocytic or erythrocytic progeny was measured. The former was determined by the response to endotoxin, and the latter by the incorporation of radioactive iron into newly formed red blood cells. Erythropoiesis, therefore, could be measured independently from granulopoiesis by these techniques. The third method used was the spleen colony method of Till and McCulloch. Recipient animals exposed to 150 R preirradiation, seven days before 700 R and bone marrow transplantation, demonstrated an increase in erythropoiesis with a concomitant decrease in granulopoiesis compared to similar recipients not preirradiated. The spleen colony technique showed that while the number of colonies were the same in both groups, the colonies themselves were significantly larger in the preirradiated animals. Since such colonies are primarily erythropoietic, this finding is consistent with the other methods. The results can be explained by assuming the presence of a hematopoietic stem cell that, in these preirradiated recipients, is directed towards erythropoiesis at the expense of granulopoiesis. (auth)

23420 STUDY OF THE ABILITY OF γ-IRRADIATED LYSOZYME TO UNDERGO AGGREGATION USING SOLUBILITY AND GEL-FILTRATION METHODS. Maksimov, V. I.; Osipov, V. I. (Inst. of Organic Chemistry, Moscow). Biochemistry (USSR) (Engl. Transl.), 32: 81-6(Jan.–Feb. 1967).

Translated from Biokhimiya, 32: 98–105(Jan.–Feb. 1967).

The solubility of lysozyme falls after γ irradiation (exposure of the dry enzyme to 30 Mrad in an atmosphere of nitrogen), the effect being the more marked the higher the pH and ionic strength of the medium. The irradiated product retains the properties of native lysozyme, except for a heightened tendency towards aggregation. Irradiated lysozyme could be separated into two fractions by a salting out procedure. Fraction I was inactive, while fraction II had 80 to 85% of the activity of the native enzyme. The curve expressing the pH dependence of aggregation of fraction I in $^1/_{15}$ M phosphate buffer resembles the titration curve of a proton donor of $pK_a = 6 - 7$. Fraction II was soluble in this buffer, at any pH. Filtration through Sephadex G-100 columns gave results which were not consistent with the attribution of the anomalous behavior of lysozyme in buffer solutions to ion-exchange properties of the

gel, or to formation of loose complexes involving participation of the active site of the enzyme. Fraction II could not be distinguished from native lysozyme in its behavior when passed through a Sephadex G-100 column. Under certain conditions, fraction I could be separated by gel filtration into two components, for one of which $V_e = V_0$, while the other emerged from the column somewhat earlier than native lysozyme. The former component is thought to be a molecular aggregate, and the latter to be partially denatured lysozyme. (auth)

23421 ACTION OF X-RAYS ON ACCEPTOR ACTIVITY OF SOLUBLE RNA OF AZOTOBACTER. Miroshnichenko, T. P.; Zaitseva, G. N.; Matsuka, G. Kh.; Akhmedov, G. I. (Moscow State Univ.). Biochemistry (USSR) (Engl. Transl.), 32: 125-9(Jan.-Feb. 1967).

Translated from Biokhimiya, 32: 150-5(Jan.-Feb. 1967).

The acceptor function of sRNAs specific to different amino acids is modified to a different degree by the action of x rays in a dose of 25 kR. Lysine-, isoleucine-, glutamate-, threonine-, and arginine-specific sRNAs are most sensitive to irradiation. The sRNAs specific toward tyrosine, methionine, tryptophan, valine, leucine, and phenylalanine undergo practically no change in their acceptor ability, demonstrating their relatively high radiosensitivity. The sRNAs accepting histidine and proline occupy an intermediate position as regards radiosensitivity. Fractionation on methylated albumin columns showed that different isoacceptor sRNAs, i.e., sRNAs accepting the same amino acid (for lysine, isoleucine, glutamic acid, and threonine) differ in their sensitivity to x ray irradiation. It may be concluded from the results obtained that under the influence of x rays a selective disturbance of the structure of certain sRNAs takes place, as a result of which they lose their biological activity. (auth)

23422 EFFECT OF IONIZING RADIATION ON ANIMAL LIVER, KIDNEY, HEART, AND BRAIN INVERTASE, AND THE INFLUENCE OF RADIOLOGICAL TREATMENT ON PATIENTS' SERO-INVERTASE ACTIVITY. Huang, Ta-yu; Tao, Chi-min; Liu, Keng-nien; Chen, Shan-shan. Chung Hua I Hsueh Tsa Chih, 49: 176-81(Mar. 1963). (In Chinese).

The effects of x radiation on invertase activity in the brain, heart, kidney, and liver of rats were investigated. An increase in the activities of glutamic-oxalacetic transaminase and glutamic-pyruvic transaminase was noted; this was correlated with carbohydrate metabolism disorders. It was found that irradiation of cervical cancer could not be used as an index of quantitative therapeutic radiation lesions. (JPRS)

23423 EFFECT OF γ RADIATION AND RADIOTOXINS ON THE SYNTHESIS OF DNA IN EARLY EMBRYOGENESIS OF THE GROUNDLING MISGURNUS FOSSILIS. Neustroev, G. V.; Kondratenko, V. G.; Kuzin, A. M. Izv. Sib. Otd. Akad. Nauk SSSR, Ser. Biol.-Med. Nauk, No. 5, 95-9(Apr. 1967). (In Russian).

The comparative investigation of the effects of γ radiation and radiotoxins on the synthesis of DNA, in developing embryos of Misgurnus fossilis in early embryogenesis, led to the conclusion that there was a dependence between the depression of the synthesis of DNA in the embryo cells and the destruction of the embryo. In early embryogenesis, Misgurnus fossilis had a different sensitivity of DNA synthesis to the effect of ionizing radiation and radiotoxins. The gastrula stage (period of initial differentiation) seemed to be the most sensitive. The comparison of the results of γ radiation and radiotoxins on the DNA synthesis indicated that the radiotoxins were responsible to a significant degree for the development of radiation damage in the embryonic cells. (tr-auth)

23424 COMPARATIVE STUDY OF FREE RADICALS AND RADIOSENSITIVITY OF SEEDS. Ermolaev, V. K.; Lebedeva, L. I.; Kerkis, Yu. Ya. Izv. Sib. Otd. Akad. Nauk SSSR, Ser. Biol.-Med. Nauk, No. 5, 147-54(Apr. 1967). (In Russian).

The results of the comparison of the radiosensitivity and radical yields in seeds, irradiated at -196°C, when the radicals were stabilized and did not participate in chemical reactions, were reported. It was shown that there was no quantitative correlation between them. The biochemical state of the seeds was determined. The studies were made on Pisum sativum, Vicia faba, Lactuca sativa, Sinapis alba, and Brassica juncea. (J.S.R.)

23425 RADIOSENSITIVITY OF THE COMPONENTS OF TISSUE RESPIRATION AND PROCESS OF RECOVERY OF THE PRIMARY INJURY. Amiragova, M. I.; Savich, A. V. Izv. Sib. Otd. Akad. Nauk SSSR, Ser. Biol.-Med. Nauk, No. 5, 132-5 (Apr. 1967). (In Russian).

The radiosensitivity of separate groups of porphyrin complexes in aqueous solutions was investigated under conditions where the changes were caused by reactions with the products of water radiolysis. The irreversible oxidative destruction of the porphyrin ring in the presence of the hydroxyl radical (OH) was shown; the presence of irreversible changes of the secondary substitute in the partial destruction of the porphyrin ring was established. The conditions for the irreversible reduction of the porphyrin ring were determined. The reversible reactions detected were the oxidation and reduction of iron and characteristics of the ferro-derivatives of porphyrin were investigated. The reactions responsible for the hidden damage, detected only after the effect of a supplementary factor, were established. (J.S.R.)

23426 INVOLVEMENT OF SULPHHYDRYL GROUPS IN RADIATION DAMAGE TO THE HUMAN ERYTHROCYTE MEMBRANE. Sutherland, R. M.; Stannard, J. N.; Weed, R. I. (Univ. of Rochester, New York). Int. J. Radiat. Biol., 12: 551-64(1967).

X irradiation produces effects on several membrane permeability parameters of human erythrocytes (K^+, Na^+, choline$^+$ movements; volume; haemolysis) similar to those produced by the sulphhydryl reagent parachloromercuribenzene sulphonate (PCMBS). However, x irradiation does not alter glucose transport, in contrast to the inhibition resulting from PCMBS treatment. The results of additivity and subtractivity experiments are consistent with the proposal that PCMBS and x irradiation produce increased K^+ permeability by acting on common sites (-SH groups) in the membrane. The kinetics of K^+ efflux at room temperature and the increased rate of K^+ efflux at low temperature suggest the existence of membrane repair processes. Doses of x-radiation which alter K^+ permeability also result in the loss of membrane -SH groups, and part of this loss is due to disulphide formation. It is suggested that these changes of -SH groups after x irradiation are primary events in the alterations of membrane structure leading to the increased K^+ permeability observed. (auth)

23427 ROLE OF TRYPTOPHAN IN THE INACTIVATION OF DEOXYRIBONUCLEASE. Armstrong, R. C.; Charlesby, A. (Royal Military Coll. of Science, Shrivenham, Eng.). Int. J. Radiat. Biol., 12: 523-34(1967).

Deoxyribonuclease I (DNAase I) was irradiated in dilute solution under aerobic and anaerobic conditions, using alpha and gamma radiations with a view to investigating an earlier suggestion that radiation-induced inactivation was caused by the destruction of a tryptophan residue at the active site. The relation between the loss of tryptophan, and inactivation of the enzyme, both by chemical attack and by irradiation, was studied. The action of a specific inhibitor confirmed the importance of tryptophan to the enzymic activity of DNAase I. DNAase II did not show such a marked dependence on tryptophan for its activity, and parallel studies were made on this enzyme for comparison. However irradiation studies indicated that there was no correlation between tryptophan destruction and the radiation-induced inactivation of DNAase I. It is suggested that inactivation may result from changes in conformation. (auth)

23428 THE INFLUENCE OF EXTERNAL GAMMA RADIATION ON ANTIBODY PRODUCING CELLS BY ERNE'S METHOD. Petrova, I. V.; Kartasheva, A. L. (Inst. of Medical Radiology, Academy of Medical Sciences, USSR). Byull. Eksp. Biol. Med., 64: 68-9(Aug. 1967). (In Russian).

Mice of CBA strain were immunized with sheep erythrocytes and then on the third day irradiated with various doses (330 and 660 R) of gamma rays. The number of antibody-producing cells decreased compared to the non-irradiated mice by two to seven times. The difference is statistically significant. Titers of antibodies in the blood do not differ practically from those in immunized, but non-irradiated mice. (auth)

23429 RHYTHMIC DISRUPTION OF CATABOLIC PROCESSES WITH SMALL DOSE IRRADIATION. Druzhinin, Yu. P.; Benevolenskii, V. N. pp 145-50 of Voprosy Obshchei Radiobiologii. Domshlak, M. P. (ed.). Moscow, Atomizdat, 1966. (In Russian).

Literature studies suggest that proteolytic activity of the blood can be used to detect intracellular membrane damage produced by small dose irradiation. For a more detailed study of proteolytic activity, experiments were carried out on white rats x-irradiated in a wide range of doses: 0.75, 1.5, 3, 6, 12.5, 25, and 50 R at a dose rate of 12.75 R/min (first series) and 100, 200, 400, 800, and 1600 R at a dose rate of 59.5 R/min (second series). The proteolytic activity of the blood was determined before irradiation and during the following 30 days. Blood (0.1 ml) was incubated with bovine serum (0.9 ml) for 3 hrs and then the level of amino nitrogen was determined. Results of the first series showed that the dynamics of blood proteolytic changes for all animals represented a distinct curve characterized by two peaks. These peaks appeared on the third and seventh days for a dose range of 0.75 to 6 R, and appeared after 6 hrs and on the third day for a dose range of 12.5 to 50 R. To determine whether the proteolytic phase changes fol-

lowed a similar curve with larger doses and to determine the nature of blood formed elements, additional experiments were carried out on five dogs irradiated at single 300 or 500 R doses. In these cases, the peaks were found on the seventh and 20th days. No dose dependence was observed within this dose range, but the appearance of the peaks clearly depended on the degree of radiation sickness. Dynamics of blood formed elements (erythrocytes and leukocytes) did not correlate with the proteolytic changes of the whole blood. These changes could be the result of fluctuations of proteolytic enzyme inhibitors on activators in the plasma or of proteolytic enzymes leaving the tissues. It appeared that the proteolytic phase changes did reflect the rhythm of catabolic processes and were related to a certain degree to intracellular membrane damage. (ATD)

23430 X AND γ IRRADIATION IN RADIOBIOLOGICAL EXPERIMENTS. PHYSICAL AND TECHNICAL PRINCIPLES AND SOLUTIONS. DATA ON THE IMPORTANCE OF VARIOUS FACTORS DETERMINING THE DOSE DEPENDENCE OF BIOLOGICAL EFFECTS. Domshlak, M. P.; Darenskaya, N. G.; Khrushchev, V. G.; Koznova, L. B.; Stepanov, S. M. pp 7-33 of Voprosy Obshchei Radiobiologii. Domshlak, M. P. (ed.). Moscow, Atomizdat, 1966. (In Russian).

Characterizations were given of the special equipment used as γ-emitters in radiobiological experiments for chronic irradiation and in acute and local therapy, investigations in microbiology, cytology, biophysics and biochemistry, study of the radiobiological importance of the time of irradiation, and of x-ray equipment used for some of those purposes. The quantitative dependence of the damaging effect of radiation was considered from various aspects (space and time distributions and biological factors). Recommendations were given regarding the equipment to be used for given purposes, selection of the dose level and considerations in evaluating results. (JPRS)

23431 TISSUE CULTURE METHOD IN RADIOBIOLOGICAL INVESTIGATIONS. Leonov, B. V.; Mikhailova, A. A. pp 135-44 of Voprosy Obshchei Radiobiologii. Domshlak, M. P. (ed.). Moscow, Atomizdat, 1966. (In Russian).

A literature survey and data on tissue culture methods in radiobiological studies are presented. The material indicated that tissue cultures were good models for studying various aspects of radiobiological effects: effects of irradiation dose size and rate on the degree of radiation injury, radiobiological action with different ionization density, restoration processes of irradiated cells and problems of radioprotection. Growth of tissue cultures in the form of a layer or suspension made it possible to conduct physicochemical and histological investigations of protein, lipid and carbohydrate metabolism. Experimental data based on tissue culture investigations concurred with the present position of radiobiology. (ATD)

23432 EVIDENCE FOR A RELATIONSHIP BETWEEN DEOXYRIBONUCLEIC ACID METABOLISM AND SEPTUM FORMATION IN ESCHERICHIA COLI. Walker, James R.; Pardee, Arthur B. (Princeton Univ., N. J.). J. Bacteriol., 95: 123-31 (Jan. 1968).

Septum formation is a key step in bacterial division, but the mechanism which controls periodic septum formation is unknown. In an attempt to understand this mechanism, lon^- mutants, in which septum formation is blocked by very low doses of ultraviolet light (uv), were investigated. Uv must act on some part of the apparatus of cytokinesis; thus, identification of the uv target would identify part of this apparatus. As likely possibilities, uv might damage the septum-forming site or it might damage deoxyribonucleic acid (DNA), since DNA replication is normally coordinated with septum formation. To distinguish between these possibilities, DNA was specifically sensitized by incorporating bromodeoxyuridine into lon^- bacteria. These bacteria were strongly sensitized to longer wavelength uv (2,900 to 3,100 A) so that they failed to form septa, grew into filaments which lysed, and did not form colonies. Various control experiments supported the conclusion that uv inhibits septum formation as a result of alterations in DNA metabolism. A relation thus exists between DNA metabolism and septum formation. (auth)

23433 THE EFFECT OF PRECEDING BLOOD TRANSFUSIONS ON THE FATE OF HOMOLOGOUS BONE MARROW GRAFTS IN LEATHALLY IRRADIATED MONKEYS. van Putten, L. M.; van Bekkum, D. W.; de Vries, M. J.; Balner, H. (Radiobiological Inst., TNO, Rijswijk, Netherlands). Blood, 30: 749-57(Dec. 1967).

Attempts at bone marrow transplantation after total body irradiation in Rhesus monkeys which have received multiple blood transfusions leads only rarely to acceptance of the graft, whereas in animals that were not previously transfused, a take of the graft is the rule. Immunization against subsequent bone marrow transplants was not only observed after transfusions with blood from the future donor, but also after multiple transfusions from unrelated third-party donors. From these observations in monkeys it is concluded that many of the failures to observe a take of attempted bone marrow transplants in man may be related to the fact that the recipient had received multiple blood transfusions prior to transplantation. (auth)

23434 MARROW ENGRAFTMENT BY ALLOGENEIC LEUKOCYTES IN LETHALLY IRRADIATED DOGS. Storb, R.; Epstein, R. B.; Ragde, H.; Bryant, J.; Thomas, E. D. (Univ. of Washington, Seattle). Blood, 30: 805-11(Dec. 1967).

Infusion of white blood cells separated from peripheral blood produced allogeneic bone marrow engraftment in lethally irradiated dogs. Approximately 100×10^9 leukocytes obtained from a single donor over an 8-day period were adequate to establish marrow repopulation. Marrow engraftment was indicated by rising blood count, marrow histology, and, in one instance, cytogenetic studies. Marrow grafts were associated with a severe secondary syndrome. Survival was prolonged with methotrexate. (auth)

23435 ANALYSIS OF PRIMARY LOCAL DAMAGE TO DNA ISOLATED FROM THE LIVER AND THYMUS OF IRRADIATED RATS. Ivannik, B. P.; Ryabchenko, N. I. Radiobiologiya, 7: 332-3(1967). (In Russian).

After rats had been irradiated with γ-rays in doses of 5–100 kR, the frequency of single-strand cleavages in DNA isolated from the liver and thymus was determined. The number of cleavages increased linearly with the radiation dose (for liver DNA at 5 to 100 kR and for thymus DNA at doses >25 kR), just as on irradiation of DNA in vitro. The energy required for one cleavage was calculated as 28.0 and 29.0 eV for liver DNA and thymus DNA, respectively. The behavior of DNA under irradiation was the same as that of synthetic polymers; this indicated that the degradation of DNA was due to the direct action of radiation. The radiosensitivity of DNA in the liver and thymus was the same, although the content of DNAase in these two organs and the effects of radiation on DNAase activity in them differed, i.e., degradation of DNA was not due to activation of DNAase by radiation. (JPRS)

23436 STRUCTURAL AND FUNCTIONAL SITES OF ACTION OF ULTRAVIOLET RADIATIONS IN CRAB NERVE FIBERS. II. LOCALIZATION OF THE SITES OF ACTION OF UV RADIATION BY EXPERIMENTS WITH Ca^{2+} AND OUABAIN. Lieberman, E. M. (Univ. of Florida, Gainesville). Exp. Cell Res., 47: 508-17(Sept. 1967).

Evidence is presented that the Na^+-conductance mechanism (285 mμ sensitive) is located on the outer surface of the membrane. Evidence is also presented that the K^+-conductance mechanism (255 mμ sensitive) is located on the inner surface of the membrane. A comparison of effects of ultraviolet radiation and a cardiac glycoside on the electrical activity of crab axons implicates a membrane related Na^+-K^+-activated ATPase system as the ultraviolet-sensitive site. These data may indicate a correlation between the activity of the Na^+-K^+-activated ATPase, its structural relation to the membrane and excitability characteristics of the crab axon. (auth)

23437 STRUCTURAL AND FUNCTIONAL SITES OF ACTION OF ULTRAVIOLET RADIATIONS IN CRAB NERVE FIBERS. III. THE PHOTOINACTIVATION OF A Na^+-K^+-ACTIVATED ATPase SYSTEM AND ITS CORRELATION WITH INACTIVATION OF EXCITABILITY. Lieberman, E. M. (Univ. of Florida, Gainesville). Exp. Cell. Res., 47: 518-35(Sept. 1967).

A highly active Na^+-K^+- and Mg^{2+}-activated ATPase was present in crab peripheral nerve. This ATPase system was effectively inactivated by 255 and 285 mμ radiations, out unaffected by 330 mμ radiations. The Mg^{2+}-activated ATPase system was minimally affected by 255 and 285 mμ radiations. The presence of ATP had a slight shielding effect on the enzyme system to 255 mμ, but not 285 mμ radiations. The shielding was due to the absorption of 255 mμ radiation by the ATP, not necessarily to the effects of the ATP on the enzyme, itself. The effectiveness of the monochromatic radiations for enzyme inactivation did not depend on its in vitro activation state. A model of the structural and functional characteristics of the nerve cell membrane was proposed in which were integrated the electrophysiological and biochemical findings of this investigation. The site of action of 255 mμ was placed on the inner surface of the membrane associated with a protein site essential for ATPase activity and calcium binding. The site of 285 mμ action was placed on the outer surface of the membrane associated with a protein site essential for ATPase activity and sodium permeability characteristics of the membrane. (auth)

23438 EFFECT OF RADIATION ON SUGARS OF THE CELL WALL OF ASPERGILLUS NIGER. Wang, Jy-shih. Bull. Inst. Chem., Acad. Sinica, No. 14, 24-8(Dec. 1967).

Paper chromatographic analysis of the acid-hydrolyzed Aspergillus niger cell wall showed the presence of four neutral sugars: glucose, galactose, mannose, and arabinose. Paper chromatographic analysis of Aspergillus niger cell wall after irradiation with ^{60}Co γ rays was carried out. The chromatograms showed that a part of the cell wall was degraded into sugars. Glucose and galactose were produced prior to mannose and arabinose after irradiation. The sugars were approximately estimated according to size of spots on chromatograms. (auth)

23439 REDUCTION OF DISULFIDE GROUPS IN PHOSPHOPROTEIN OF EGG YOLK BY SODIUM THIOGLYCOLLATE. Yuan, Hui-yin. Bull. Inst. Chem., Acad. Sinica, No. 14, 42-9 (Dec. 1967).

The disulfide groups in hen egg phosvitin and hen egg vitellin could be reduced to sulfhydryl groups by treating with sodium thioglycollate, and the amounts of sulfhydryl groups were increased by about 0.003%–0.009% after reduction. Amperometric titration with dilute silver nitrate solution was used to determine the amount of sulfhydryl groups contained in hen egg phosvitin and hen egg vitellin. Also the spectrophotometric method using p-chloromercuribenzoate was employed for comparison. When the samples were irradiated by x rays, the amount of sulfhydryl groups was decreased. (auth)

23440 STRUCTURAL AND FUNCTIONAL SITES OF ACTION OF ULTRAVIOLET RADIATIONS IN CRAB NERVE FIBERS. I. THE ELECTROPHYSIOLOGICAL EFFECTS OF ULTRAVIOLET RADIATIONS. Lieberman, E. M. (Univ. of Florida, Gainesville). Exp. Cell Res., 47: 489-507(Sept. 1967).

Utilizing monochromatic ultraviolet radiations as a tool to specifically alter molecular structure it was possible to study excitable membrane electrical characteristics as a function of membrane structure. It was shown that molecules that absorb specific monochromatic radiations are associated with specific excitability characteristics. That is, some molecule that absorbed 285 mμ radiation was associated with the action potential (Na^+-conductance) mechanism and some molecule that absorbed 255 mμ radiation was associated with the critical firing level (Ca^+-binding) mechanism and membrane resistance and potential (K^+-conductance) mechanism. (auth)

23441 PERCUTANEOUS ABSORPTION OF RADIOACTIVE STRONTIUM CHLORIDE ^{89}Sr ($^{89}SrCl_2$). A COMPARISON WITH 11 OTHER METAL COMPOUNDS. Wahlberg, Jan E. (National Inst. of Occupational Health, Stockholm, Karolinska Sjukhuset, Stockholm). Arch. Dermatol., 97: 336-9(Mar. 1968).

The percutaneous absorption of strontium chloride in six different concentrations (0.00013 to 0.753M) was studied in the guinea pig using ^{89}Sr as a tracer. It was found that the relative absorption was about the same (2.5 to 3.1% during a five-hour period) in the concentration interval 0.008 to 0.398M, with the maximum at 0.080M. The absolute absorption increased with increasing concentration. A summary comparison showed that the absorption of strontium chloride was of the same order of magnitude as that observed for metal compounds previously studied. The rapid absorption of strontium compounds reported in the literature could not be verified. (auth)

23442 EFFECT OF X-RADIATION ON THE TRYPTIC DIGESTION OF ALBUMIN AND ERYTHROCYTE MEMBRANE PROTEINS. Myers, D. K.; Bide, R. W.; Tribe, T. A. (Chalk River Nuclear Labs., Ont.). Can. J. Biochem., 45: 1973-83 (Dec. 1967).

Bovine serum albumin was more susceptible to tryptic digestion after x irradiation. This was probably because of an increase in the number of peptide bonds readily available for enzymic hydrolysis. However, the irradiated albumin did not show any marked change in its physical properties. The effect of x radiation on the albumin was attributed, at least in part, to the radiation-induced cleavage of a small fraction of the S–S bonds in the albumin molecule. Similar effects were noted after irradiation of intact erythrocytes. Low concentrations of trypsin, chymotrypsin, or papain removed the protein on the exterior surface of the cell membrane much more rapidly from irradiated (60 kRads) than from control cells, thus resulting in a high degree of sensitization to snake venom phospholipases. (auth)

23443 STUDIES ON THE ROLE OF INFECTION AND IONIZING RADIATION IN THE FORMATION OF COMPLEMENT-FIXING AUTOANTIBODIES. Vulchanov, V. H. (Inst. of Microbiology, Sofia); Vassilev, V. N.; Obretenova, Klara. Folia Biol. (Prague), 13: 441-9(1967).

Complement-fixing antibodies against the lungs, spleen, brain, and testis were demonstrated in the sera of guinea-pigs infected with 0.1 or 0.01 mg of Mycobacterium tuberculosis H37Rv, the time of appearance of antibodies (30th to 45th day) being correlated to the dose of the pathogen. In animals exposed to whole-body x irradiation (400 R) or γ irradiation (350 R) 24 hours before infection the percentage of antibody manifestation was higher. This effect was attributed not only to the fact that the post-irradiation tissue damage leads to a wider and deeper spread of the infection, but also to the fact that irradiation by itself may induce the formation of anti-organ autoantibodies. In infected animals irradiation caused inhibition of delayed hypersensitivity (up to the 15th to 30th day), as well as inhibition of antibody formation with respect to the pathogen, as detected by the haemagglutination test (on the 30th day after infection). Only in single cases skin tests with saline extracts of lymph nodes, leukocytes, and brain, were positive on the 30th day or later after infection. The role of ionizing radiation in increasing the possibility of inducing autoantigenicity (characterized by the presence of CF antibodies) in experimental tuberculosis is discussed. (auth)

23444 FREE RADICALS OF BIOLOGICAL INTEREST. PART II. ELECTRON SPIN RESONANCE (ESR) SPECTRA OF 2537 A IRRADIATED AMINO ACIDS. Forbes, W. F.; Sullivan, P. D. (Univ. of Waterloo, Ont. Univ. of Rochester, N. Y.). Can. J. Biochem., 45: 1831-9(Dec. 1967).

Polycrystalline amino acids, when irradiated with uv light, afford a variety of electron spin resonance signals. These signals are generally stable at room temperature for relatively long periods of time. For a number of the spectra obtained, there is evidence that more than one radical species contributes to the observed spectra. The signals obtained frequently differ from those obtained on exposure to ionizing radiation. The postulated species formed can often be visualized as being formed by effective hydrogen abstraction from the alkyl-substituted tertiary carbon atom or from the –OH, –SH, or –NH group contained in the side chain. For L-phenylalanine a secondary radical is obtained, which is ascribed to a cyclohexadienyl radical. (auth)

23445 THE EFFECT OF RADIATION ON DEOXYRIBONUCLEOPROTEINS IN ANIMAL TISSUE. III. THE CHARACTER OF THE POLYDEOXYRIBONUCLEOTIDES RELEASED FROM IRRADIATED TISSUES. Skalka, M.; Matyasova, Jitka (Inst. of Biophysics, Brno). Folia Biol. (Prague), 13: 457-64(1967).

Some of the conditions of the determination and behavior of the polydeoxyribonucleotides (PDN) released from the nucleoprotein complex of the cell nucleus of lymphatic tissues from whole-body x-irradiated mice (600 R) were studied. Comparison of different methods of determination showed that the diphenylamine reaction gave accurate results. It was also found that the PDN were not retained on Sephadex G-200, and that they were eluted with part of the proteins in the first fraction, indicating that their molecular weight is over 200,000. Further experiments showed that these PDN are probably still bound to protein. In deproteinization with chloroform and amyl alcohol or with phenol they were not extracted into the aqueous phase unless high NaCl concentrations were used. They were precipitated from solutions by histone and the precipitate contained more protein than histone-precipitated DNA or crude deoxyribonucleoprotein. The last experiments showed that the homogenization of lymphatic tissues in water or 1.2M NaCl solution before starting normal fractionation in 0.14M NaCl did not affect the difference between the PDN content of normal and irradiated tissues. (auth)

23446 THE X RAY AND NEUTRON IRRADIATION EFFECT ON CHOLINESTERASE IN THE WHITE RAT LIVER AND SKELETON MUSCLES. Khripchenko, I. P.; Gromyko, A. S. (Belorussian State Univ., USSR). Dokl. Akad. Nauk BSSR, 11: 455-6(May 1967). (In Russian).

The role of enzyme processes in pathological and compensatory reactions during radiation sickness was considered in the investigation of the effect of comparatively small doses of x radiation at 40 R and neutrons of intermediate energy at a dose of 13 Rad on the activity of cholinesterase in the liver and skeletal muscles of the white rat. The studies were made on the cellular level within one to five hours after irradiation. The most substantial and statistically reliable changes of the activity of cholinesterase were detected in the skeletal muscles following both x- and neutron irradiation. Another picture was observed with respect to the cholinesterase activity of the liver. The possibility that the observed displacements were connected with the factors of intracellular distribution of cholinesterase and the corresponding reactions of the nervous system to the irritant are considered. (tr-auth)

23447 CONTENT OF FREE AMINO ACID, ADJOINING RINGS OF TRICARBOXYLIC ACID, AND THEIR ACETYL DERIVATIVES

IN SUBCELLULAR FRACTIONS OF THE BRAIN DURING X IRRADIATION. Pikulev, A. T.; Dovgalevich, I. I. Vestsi Akad. Navuk BSSR, Ser. Biyal. Navuk, No. 4, 58-63(1967). (In Russian).

After whole-body x irradiation of rats at doses of 40 R, the content of the different amino acids in the brain was altered to different degrees. The content of glutamine, alanine, and asparagine in the grey and white matter of the cerebrum and in the cerebellum increased on the seventh and fifteenth day after exposure to ionizing radiation. At the same time the content of N-acetyl-L-asparagine was reduced at all levels of the central nervous system on the seventh day and was increased on the fifteenth day in comparison with levels established in controls. These results did not reflect changes that were found in the separate subcellular fractions. Changes of the ratio in the content of the same amino acids in subcellular fractions of mitochondria and nuclei after irradiation were compared with those in healthy rats. The results obtained on the changes of the free amino acids and their acetyl derivatives during x irradiation were compared with the changes of the activity of enzymes taking part in the exchange of these amino acids, and also with the changes of the physical and chemical properties of the separate organelles. (tr-auth)

23448 CHAIN SCISSION OF RIBONUCLEIC ACID AND DEOXYRIBONUCLEIC ACID BY IONIZING RADIATION AND HYDROGEN PEROXIDE IN VITRO AND IN ESCHERICHIA COLI CELLS. Pollard, Ernest C.; Weller, Patricia K. (Pennsylvania State Univ., University Park). Radiat. Res., 32: 417-40(1967).

A survey has been made of the effects of heat, ionizing radiation, and hydrogen peroxide on DNA and RNA both in vitro and in the living cell. The effects of these agents were observed by using trichloroacetic acid (TCA) precipitation. Because of the value of TCA precipitation in many biochemical and biological studies, an attempt has been made to obtain quantitative estimates by this technique. Semiempirical equations to describe the data have been derived and calibrated against outside work. The phosphate-potentiating effect on in vitro DNA and RNA scission by hydrogen peroxide and ionizing radiation has been verified and studied. However, there is no apparent effect on colony-forming ability. While there seems to be no striking pH effect on the action of these agents, their effect is dependent on the chemical nature of the buffer. The reduction of action in intracellular DNA and RNA, as compared to the in vitro studies, indicates that the cell can modify the effect of such agents. The in vivo work also shows that a large number of scissions can be produced in the cell without apparent radiobiological damage, indicating the existence of an intracellular repair mechanism. (auth)

23449 INFLUENCE OF LOW X-RAY DOSES ON THE COURSE OF EXPERIMENTAL POST-VACCINATION INFECTION WITH LIVE B-19 VACCINE AGAINST BRUCELLOSIS. Lehky, F.; Otoupal, P.; Stavarek, V. Vet. Med. (Prague), 12: 657-66(Nov. 1967). (In Czech).

The influence of x radiation on the course of immune reactions was followed in guinea-pigs following whole-body x irradiation (75 and 100 R) and simultaneous vaccination with live Brucellosis vaccine (subcutaneously with 1.10^9 microbes). (auth)

23450 EFFECTS OF LOW SUB-STERILISING DOSES OF GAMMA RADIATION ON CARBON, NITROGEN, AND PHOSPHORUS IN FRESH SOILS. Cawse, P. A. (Wantage Research Labs., Eng.). J. Sci. Food Agr., 18: 388-91(Sept. 1967).

Changes in ammonium- and nitrate-nitrogen were shown to be a sensitive indication of response of soils to gamma radiation, even to doses as low as 1.5 kilorads, and are superior to measurements of carbon, phosphorus, or respiration. The immediate increase in carbon in the soil solution after irradiation was significantly correlated with both subsequent nitrogen mineralization and soil respiration, and a highly nitrogenous fraction of the soil organic matter was being decomposed. Nitrification proceeded at a fast rate in all soils after the highest dose of 200 kilorads, probably owing to the absence of effects on the oxidation process in non-proliferating cells of the nitrifying bacteria rather than to increased proliferation of survivors. (auth)

23451 REPAIR OF RADIATION DAMAGE TO MEMBRANE SULFHYDRYL GROUPS OF HUMAN ERYTHROCYTES. Sutherland, Robert M.; Pihl, Alexander (Norsk Hydro's Inst. for Cancer Research, Oslo). Biochim. Biophys. Acta, 135: 568-70 (July 3, 1967).

When fresh human erythrocytes were irradiated at 4° with 196 kR of x ray, the –SH content of the membranes isolated immediately after exposure was 25% lower than in those isolated from unirradiated control cells. When the irradiated cells were incubated for one h at 4°, in the presence or absence of glucose, the radiation-induced loss of membrane –SH groups was the same (about 25%) as immediately after the exposure. This was also the case in cells kept at 37° in the absence of glucose. However, when the cells were incubated at 37° in the presence of glucose, the –SH content of their membranes was only 10% lower than in the unirradiated control cells. Since the membrane –SH content of the unirradiated cells was found to remain constant during the incubation, the results demonstrate that in the irradiated cells kept at 37° in the presence of glucose the concentration of membrane –SH groups increased during incubation. Apparently, under these conditions repair processes were operating that resulted in the recovery of about 60% of the –SH groups that disappeared upon irradiation. (C.H.)

23452 EFFECTS OF LASER RADIATION ON TISSUE CULTURE CELLS. Kavets'kii, R. E.; Gamaliya, M. F. (Inst. of Experimental and Clinical Oncology, Kiev). Dopov. Akad. Nauk Ukr. RSR, Ser. B, No. 11, 1042-6(1967). (In Russian).

Cultures of Hela, Hep-2, and KB tumor cells were irradiated with unfocused ruby laser beams. Two types of cell damage were observed: individual dead cells scattered among intact cells, and formation of distinctly outlined foci in which all cells were destroyed and strikingly deformed. A two-layer preparation technique showed that radiation injuries in the monolayer were not a simple consequence of laser beam power heterogeneity. They were determined by interaction of the beam with the cell monolayer. Analysis of the injury foci indicated that effects other than the usual thermal one may be involved, in particular, mechanical factors such as a pressure wave. Janus green, brilliant green, and methylene blue proved to be the most active among 25 dyes tested in regard to their ability to sensitize the cells to ruby laser radiation. (H.L.W.)

23453 MOTION OF ISOLATED MITOCHONDRIA: ITS CHARACTERISTICS AND RESISTANCE TO IRRADIATION OF THE BODY WITH LETHAL DOSES OF IONIZING RADIATION. Pelishenko, I. A. (Kirov Medical Military Academy, Leningrad). Vop. Med. Khim., 13: 615-17(Nov.-Dec. 1967). (In Russian).

Mitochondria isolated from tissues of rat display independent rotation and feeble translation motion as can be shown by means of phase-contrast microscopy. The same picture took place for mitochondria isolated from tissues of the rats subjected to x irradiation at lethal and sublethal doses. (auth)

23454 ACTIVITY OF ALKALINE AND ACID PHOSPHATASE IN BONE TISSUE OF RABBITS AFFECTED WITH ^{239}Pu. Elkina, N. I.; Libinzon, R. E. (Inst. of Biophysics, Moscow). Vop. Med. Khim., 13: 591-7(Nov.-Dec. 1967). (In Russian).

Alkaline and acid phosphatase activity was 1.3 to 2.7 times greater in the spongy tissue of rabbit bone, in comparison with diaphysis. During the period from the 90th to the 635th day of rabbits' life the alkaline phosphatase activity in various bone areas fell 4 to 5 to 10 times, and the acid phosphatase activity diminished by 2.8 times. With increase of the rabbits' age from 90 to 635 days the activity of alkaline phosphatase in the blood serum was reduced 2 to 3 times. Seven days after the introduction of plutonium in a dose of 7 microcurie/kg the activity of alkaline phosphatase in the vertebrae and the epiphyses constituted 71 and 51%, respectively (as compared to control). In this group of animals low enzymatic activity persisted for 180 days after plutonium administration. Bone tissue acid phosphatase activity was almost halved within the first 30 days after plutonium administration in a dose of 7 microcurie/kg. A rise of this enzyme activity was observed from the 30th to the 180th days. In 180 to 270 days a significant fall of the alkaline phosphatase activity followed a dose of 2 microcurie/kg of the radioelement. During the subsequent period (270 to 360 days), preceding the macroscopic detection of osteosarcomas in rabbits, there was a tendency to the rise of alkaline phosphatase activity in the bone tissue and in the blood serum of experimental animals. Alkaline phosphatase activity in the osteosarcoma tissue was 21 to 125 times greater than in the corresponding bone areas in the tumour-carrier animals. The activity of alkaline phosphatase in the blood serum of animals suffering from bone tumors was 5 to 50 times greater than that in the serum of control rabbits of the same age. (auth)

23455 INITIATION OF DNA REPLICATION AT 41°C BY γ RAYS IN A THERMOSENSITIVE MUTANT OF E. COLI INCAPABLE OF REINITIATING A REPLICATION CYCLE AT THAT TEMPERATURE. Kohiyama, Masamichi; Marcovich, Herbert (Institut Pasteur, Paris). Compt. Rend., Ser. D. 265: 1820-2(Dec. 6, 1967). (In French).

A mutant of E. coli, in which the initiation of chromosome replication is inhibited at 41°C can be induced by γ radiation to initiate a DNA synthesis that has the characteristics of a replication. (tr-auth)

23456 EFFECTS OF IONIZING RADIATION ON LECITHINS OF PLASMA. Dousset, Nicole; Douste-Blazy, Louis (Hopital de la Grave, Toulouse). Compt. Rend., Ser. D, 265: 1845-7 (Dec. 6, 1967). (In French).

Following x irradiation of α and β lipoproteins of human plasma, lipids were extracted by chloroform-methanol and phospholipids were fractionated by chromatography. Ratios of esterified fatty acids to phosphorus were determined. The percentage of phospholipids extracted from lipoproteins was determined before and after radiation and results are tabulated. The effects of radiation on esterified fatty acids/phosphorus ratios of lecithins in the α and β lipoproteins were studied and results are tabulated. It was concluded that ionizing radiations bring about oxidation of linoleic and arachidonic acids, followed by reduction of their acylated chains and liberation of molecules of malonic aldehyde. It was shown that chromatographic migration of phospholipids was influenced by the length of the acylated chain and that polarity of lecithin was augmented by reduction of the carbon chain. (H.L.W.)

23457 DIFFERENTIAL INDUCTION AND REPAIR OF ULTRAVIOLET DAMAGE LEADING TO TRUE REVERSIONS AND EXTERNAL SUPPRESSOR MUTATIONS OF AN OCHRE CODON IN ESCHERICHIA COLI B/r WP2. Bridges, Bryn A.; Dennis, Rachel E.; Munson, R. J. (Radiobiological Research Unit, Harwell, Eng.). Genetics, 57: 897-908(Dec. 1967).

Evidence is presented that a number of Escherichia coli strains have chain-terminating codons at their auxotrophic loci. They may mutate to prototrophy either by true reversion at the chain-terminating codon or by mutation at suppressor loci. The two types of prototroph may be distinguished by the ability of the latter to support growth of T4 phage also carrying chain-terminating mutations. In E. coli B/r WP2 Try$^-$, which appears to have an ochre codon, both types of mutation arise spontaneously. Ultraviolet light at room temperature induced a preponderance of suppressor mutations whose frequency increased with the square of the dose: In an Hcr$^+$ strain (one able to perform excision-repair) the frequency of suppressor mutants was greatly enhanced by the addition of broth to the plating medium. The frequency of suppressor mutants fell considerably if bacteria were incubated in the absence of the required amino acid before plating on broth-enriched plates. This mutation frequency decline did not occur with true revertants which also differed from suppressor mutants in being induced linearly with dose. The sensitivity of an Hcr$^-$ strain was much greater than the Hcr$^+$ strain for the induction of both true and suppressor mutants although here the true revertants, like the suppressor mutants, were induced in proportion to the square of the uv dose. In the Hcr$^-$ strain the induction of both true and suppressor mutants was directly photoreversible and therefore presumably involved pyrimidine dimers. In the Hcr$^+$ strain there was little photoreactivation of either true or suppressor mutants indicating the primary involvement of a different lesion in the DNA. When uv was given to Hcr$^+$ bacteria at 79°C not only was the sensitivity much greater but the proportion of true revertants was much higher (around 40%) and the frequency of both true and suppressor mutants increased in proportion to a power of the dose nearer one than two. Hcr$^-$ bacteria under the same conditions were about twice as sensitive as at 22°C, the dose-squared response was retained and the proportion of true revertants was low, as at room temperature (around 10%). It is concluded that under any given conditions both true and suppressor mutations are derived largely from the same initial type of damage, such differences as are observed being due to the differential repair of damage at suppressor loci. It is suggested that mutations arise during the postirradiation modification of unexcised uv damage that passes through the DNA replication complex. (auth)

23458 SYNTHESIS OF ADRENOCORTICOTROPIN IN VITRO IN HYPOPHYSES OF NORMAL AND IRRADIATED RATS. Bezdrobnyi, Yu. V.; Grodzenskii, D. E. (Inst. of Experimental Endocrinology and Chemistry of Hormones, Moscow). Byull. Eksp. Biol. Med., 64: No. 7, 49-51(July 1967). (In Russian).

Results are reported from in vitro experiments on the uptake of labeled amino acids (glycine I-^{14}C, tyrosine I-^{14}C, and methionine ^{35}S) in ACTH of hypophyses of x irradiated and intact rats. No difference in the rate of inclusion of the labeled particle was noted. Similar experiments with hypophyses of adrenalectomized rats 7 to 11 days after operation, showed a notable increase in the speed of uptake of methionine ^{35}S into adrenocorticotropin. (auth) (TSS)

23459 STUDIES ON THE EFFECT OF X RAY IRRADIATION ON EXPERIMENTAL TUMORS. Sakamoto, Tadayuki (Osaka Univ.). Osaka Daigaku Shigaku Zasshi, 12: No. 1, 35-41(June 1967). (In Japanese).

To know the effect of radiotherapy on the tumors of the oral cavity, a study was made histologically and histochemically on the effect of irradiation on tumors of the salivary gland, developed experimentally in male mice of dd0 strain and then transplanted to other individuals of the same strain. The experimentally developed tumors were divided broadly into the epithelial and the nonepithelial types. The epithelial tumors were further divided into three types, adenoid cystic (the first type), keratotic (the second type), and medullar (the third type). In the first and second types, atrophy, cystic degeneration, and marked cornification tendency of the tumor cells and stromal proliferation were observed with x irradiation. In the third type, degeneration and disintegration of tumor cells was observed. In the nonepithelial tumors, many giant cells appeared, being subject to regressive degeneration with a lapse of time. Histochemically, succinate dehydrogenase was decreased in activity by x irradiation, except in the first type; but the activity was high in giant cells. Glucose-6-phosphate dehydrogenase was also decreased in activity by x irradiation, except in the second type, suggesting that this enzyme was related to the cornification of cells. The lactate dehydrogenase did not markedly fluctuate after x irradiation. In the third type, however, its activity in the marginal part of tumor was decreased by irradiation, though in the central part it was high. It appeared that this enzyme was related to the anaerobic state of tumor cells. The activity was high in giant cells. In the epithelial tumors, stromal proliferation was observed after x irradiation. Histochemically, the cell infiltrating layer positive in acid phosphatase reaction, was increased. (NSA of Japan)

23460 INCORPORATION OF ^{32}P INTO ONTOGENETICALLY DIFFERENT LARVAE OF THE DROSOPHILA MELANOGASTER. Faludi, B.; Szatloczky-Csukas, Iren; Keresztes, L. (Eotvos Lorand Univ., Budapest). Ann. Univ. Sci. Budapest. Rolando Eotvos Nominatae, Sect. Biol., 5: 87-95(1962).

Less ^{32}P was excreted by Drosophila when uptake occurred by 24-hr old larvae that when uptake occurred by 48-hr-old larvae. At 24 hrs more ^{32}P is incorporated into stable compounds. Distribution of ^{32}P into alcohol-soluble, acid-soluble, lipid-soluble, acid-labile, DNA, RNA, and protein fractions of pupae in various phases of development is shown by means of a table. The acid-soluble fraction shows the highest content of ^{32}P. The age at which ^{32}P was taken up by the larvae influenced the ^{32}P content of various fractions of the pupae. The ratio of the amount of ^{32}P left in the puparium by larvae that had taken up the isotope at the age of 24 hrs and that left by larvae that had taken up the isotope at 48 hrs was 3:1. (H.L.W.)

23461 THE EFFECT OF γ-IRRADIATION ON THE SOLUBLE PROTEINS OF PEA LEAVES. Grodzinskii, D. M.; Kolomiets, K. D.; Vakarenko, G. E. (Inst. of Physiology of Plants, Kiev). Radiobiologiya, 7: 916-21(1967). (In Russian).

Irradiated leaves separated from pea plants and leaves from plants grown from irradiated seeds were put in a phosphate buffer, ^{14}C-labeled aniline was added and the leaves were exposed at 22°C in an illuminated room. The proteins were separated by electrophoresis on chromatographic paper. Disturbance of protein metabolism was noted in both types of leaves in the chloroplasts, mitochondria and cytoplasm, manifested by inhibition of the inclusion of labeled aniline in the soluble protein of groups relatively immobile during electrophoresis; the inclusion of amino acid in the proteins of slightly mobile groups was intensified. In plants grown from irradiated seed, there was a tendency toward normalization of protein metabolism in the chloroplasts and mitochondria of the leaves. (JPRS)

23462 SELECTIVITY OF HUMAN AND ANIMAL ORGANISMS TOWARD RADIOISOTOPES. Shakhidzhanyan, L. G. Radiobiologiya, 7: 850-6(1967). (In Russian).

In investigations conducted during the period 1957 to 1965, 150 specimens of human and 250 of animal tissue were analyzed for the ^{137}Cs, ^{133}Cs, and ^{40}K content. Cesium-137 was not detected in the brain tissue of humans or animals, nor in any organs or tissues of fetuses or the newborn. No correlation was found between the ^{40}K and ^{137}Cs content. Parallel investigations revealed the stable isotope, ^{133}Cs, in all tissues but no correlation of ^{133}Cs and ^{137}Cs. The data indicated that man and animals have especially sensitive mechanisms (barriers) capable of detecting very slight differences between stable and radioactive atoms. (JPRS)

23463 TRANSFER TO THE NEW GENERATION OF THE ^{32}P, INCORPORATED BY THE PARENTS, AT THE DROSOPHILA MELANOGASTER MAIG. Faludi, B.; Csukas-Szatloczky, I.; Szeplaky, K. (Eotvos Lorand Univ., Budapest). Ann. Univ. Sci. Budapest, Rolando Eotvos Nominatae, Sect. Biol., 3: 171-8(1960).

The distribution of ^{32}P in the following fractions of Drosophila was determined: alcohol soluble, acid soluble, acid labile, lipid soluble, DNA fraction, RNA fraction, and protein fraction. The

value in the acid soluble fraction was especially high. A considerable increase in the acid-soluble fraction and a decrease in the alcohol-soluble fraction occurred in the pupal stage. An increase in the lipid-soluble ^{32}P occurred during development. The DNA content remained constant while the RNA content increased during development. When females containing ^{32}P were crossed with normal males, the larvae resulting from the cross contained 50 times as much ^{32}P as those obtained from reciprocal crossings. Determinations of ^{32}P content of the gametes showed that the female gamete contained a much higher percentage than the male. (H.L.W.)

23464 DISC SOLID-PHASE RADIOIMMUNOASSAY OF HUMAN LUTEINIZING HORMONE. Catt, K. J.; Niall, H. D.; Tregear, G. W.; Burger, H. G. (Prince Henry's Hospital, Melbourne). J. Clin. Endocrinol. Metab., 28: 121-6(Jan. 1968).

Solid-phase radioimmunoassay was performed by incubating specific antibody, coupled to an insoluble polymer, with the antigen to be measured and tracer antigen labeled with ^{125}I. After washing, the solid-phase was counted to quantitate the bound tracer, that varied inversely with the original antigen concentration. The preparation of the solid-phase as small discs of the substituted graft copolymer poly (tetrafluorethylene-g-isothiocyanatostyrene) further improved the procedure by allowing uniform aliquots of solid-phase antibody to be readily prepared and dispensed. The application of the disc method to the measurement of human luteinizing hormone (LH) and chorionic gonadotrophin (HCG) was achieved by the use of discs coated with antiserum to HCG, and radioiodinated LH as tracer. Comparison of LH, HCG, and human menopausal gonadotrophin (HMG) in the assay showed that the standard curves obtained for all three hormones were parallel. It was found that the disc solid-phase method was extremely convenient for the estimation of LH in human plasma and urine, giving a standard curve that is suitable for the measurement of levels encountered in the basal state and during physiological fluctuations. (H.L.W.)

23465 EFFECT OF EXTRATHYROIDAL ACTIVITY ON THE ESTIMATION OF RADIOIODIDE CLEARANCE. Shimmins, J.; Jasani, B.; Hilditch, T.; Harden, R. McG.; Alexander, W. D. (Univ. of Glasgow). J. Clin. Endocrinol. Metab., 28: 111-13(Jan. 1968).

Each of seven volunteers was given 50 μCi of ^{132}I by intravenous injection. The neck uptake was measured using a collimated NaI scintillation detector at 2, 10, 20, 30, 60, and 150 min after injection. Using various assumptions regarding extrathyroidal activity, comparisons of early and late clearances were made and results are tabulated. Another table shows thyroid clearance between 2 and 20 min calculated by measuring blood activity from body weight and body radioiodide retention and by measuring blood activity directly. It was concluded that the extrathyroidal neck activity exerted an important influence on the calculation of early clearance. (H.L.W.)

23466 LONG-TERM CHANGES IN THYROIDAL CLEARANCE RATE AFTER RADIOIODINE THERAPY. Myhill, J.; Hales, I.; Figgis, P.; Dvoskin, R. (Royal North Shore Hospital, Sydney. Univ. of Sydney). J. Clin. Endocrinol. Metab., 28: 66-72(Jan. 1968).

Thyroidal clearance rate measurements were made in 55 patients from 1 to 6 yr after receiving ^{131}I therapy for thyrotoxicosis or nontoxic goiter. A regression of clearance rate on years after therapy was calculated for each patient. The slope of this regression line was taken as a measure of the long-term effect of therapy. The intercept of the line at zero yr (i.e., the time when the last therapy dose was administered) was used as a measure of the initial effect of therapy. The initial effect was found to correlate with estimated gram rads and millicuries retained at the first therapy dose. There was no correlation with goiter type. The long-term effect was correlated with mc retained at the first dose. When this rate of fall of clearance rate was compared with the clearance rates obtained after therapy, a fall of 25% per annum was observed irrespective of thyroidal status before therapy. This was a 30-fold increase over the natural fall due to aging. (auth)

23467 INHIBITION OF A HEPATIC MICROSOMAL ENZYME SYSTEM AFTER HEAD X-IRRADIATION OF RATS. Nair, V.; Bau, D. (Chicago Medical School). Proc. Soc. Exp. Biol. Med., 126: 853-6(Dec. 1967).

Exposure to x irradiation in utero or during the early postnatal life (total body or head alone) produced a suppression of the development of hexobarbital metabolising enzyme system in liver. Abscopal inhibition of the hepatic enzyme system after x irradiation was also noted in adult male rats, but with higher radiation doses, suggesting that the central nervous system plays a regulatory role not only in the development but also in the maintenance of optimal level of enzyme activity in liver. (auth)

23468 THE INFLUENCE OF VARIOUS DOSES OF ^{60}Co γ RAYS ON ^{14}C ABSORPTION DURING PHOTOSYNTHESIS. Ibragimov, A. P.; Marfina, K. G. (Inst. of Nuclear Physics, Tashkent). Radiobiologiya, 7: 922-5(1967). (In Russian).

Cotton seeds of the variety 138-F were irradiated with doses of 1.2, 3.6 and 10 kR at 22 R/sec. Fractions were obtained from leaves and roots of plants in the two to three true leaf and cutinization phases and the activity of each fraction was investigated. It was found that different doses influenced the intensity of photosynthesis. In the first phase, photosynthesis increased with the dose. In the second, doses of one to three kR stimulated photosynthesis. Carbon-14 metabolism varied considerably; the largest amount of ^{14}C was found in the alcohol-soluble fraction (hydrocarbons). The ^{14}C inclusion increased in that fraction with the radiation dose and decreased in the acid and petroleum ether fractions. (JPRS)

23469 THE BEHAVIOR OF ^{144}Cs IN SHEEP OF DIFFERENT AGES. Buldakov, L. A.; Burov, N. I. (Inst. of Biophysics, Moscow). Radiobiologiya, 7: 881-5(1967). (In Russian).

Cesium-144-chloride was administered intravenously once and peroralloy once in doses of 11 and 4.5 μCi, respectively, to sheep 20 to 25 and 180 days old and in doses of 1.85 μCi per day for 18, 105, 300 and 1140 days perorally to animals 1.5 yr. old at the start of the experiment. After intravenous administration the biological half life of ^{144}Ce was 62.5 days from the liver and 118 days from the skeleton of lambs and 94.5 and 219 days respectively for grown animals. Cesium-144 resorbed in the intestine had a liver-skeletal character in grown animals and a skeletal one in lambs. With an increase of the period of oral administration to grown animals the isotope was increasingly concentrated in the skeleton. (JPRS)

23470 THE EFFECT OF RADIATION ON THE SYNTHESIS OF RIBOSOMAL AND DNA-LIKE RNA FROM SEED EMBROYOS. Tokarskaya, V. I.; Umanskii, S. R.; Kuzin, A. M. (Inst. of Biological Physics, Moscow). Dokl. Akad. Nauk SSSR, 177: 211-13 (Nov. 1, 1967). (In Russian).

The effects of γ radiation on the RNA with AU-type nucleotide content of seed embryos of a radiosensitive species of pea was investigated, exposing the dry or slightly moist seeds to 20 kR of a 70 R/min ^{60}Co source. The embryos were treated with a radioactive sodium phosphate solution, separating the RNA with a 0.5% solution of sodium dodecyl sulfate and phenol. The ^{32}P-labeled nucleotide content of the RNA fraction was determined after alkaline hydrolysis and electrophoresis. It was found that the RNA was synthesized with nearly identical specific activity in both irradiated and unirradiated embryos. The irradiation retarded the growth of the level of the formation of the RNA matrix; therefore the cause of the radiation induced inhibition of the development of the organism was probably due to disturbances in the regulation mechanisms of the RNA synthesis and the formation of the natural DNA-RNA complex. (TTT)

23471 ESTIMATION OF THE DISTRIBUTION OF PLANT ROOTS IN SOIL. Russell, R. Scott; Ellis, F. B. (Agricultural Research Council Radiobiological Lab., Wantage, Eng.). Nature (London), 217: 582-3(Feb. 10, 1968).

The difficulty of measuring the distribution of living roots in soil is an obstacle to quantitative studies of the performance of root systems in natural conditions. Even the most careful procedures for separating roots from soil are subject to limitations. Errors occur especially in estimates of the distribution of the finer lateral roots, and it is often impossible to distinguish between living and dead roots. One approach to the problem is to use a radioactive tracer technique. Phosphorus-32 has been used in some studies, but has serious disadvantages. The studies described in this communication employed ^{86}Rb tracer in barley plants. The applicability of the procedure to other types of plants will depend on the extent to which the tracer is translocated to roots and on the uniformity of its distribution within the roots. Perennial woody species may present special problems. Amongst other applications it should be possible to demonstrate whether changes in agronomic practice alter the distribution of living roots, a question which is often of major interest. (UK)

23472 PHARMACOLOGICAL CHARACTERISTICS OF ^{60}Co γ IRRADIATED CYCLOPHOSPHAMIDE (ENDOXAN) AND POSSIBILITY OF ITS APPLICATION TO CANCER TREATMENT. Gamo, Tetuo (Osaka Univ.). Nippon Igaku Hoshasen Gakkai Zasshi, 27: 1072-82(Nov. 1967). (In Japanese).

Endoxan is inactive in vitro. However, massively ^{60}Co-γ-irradiated crystalline Endoxan became active in vitro. The pharmacological characteristics of this irradiated Endoxan and the possibility of its application to cancer therapy were reported. (NSA of Japan)

23473 STUDIES ON THE ACTIVATION OF CYCLOPHOSPHAMIDE (ENDOXAN) WITH IONIZING RADIATION. Yoshimura, Shosuke (Osaka Univ.). Nippon Igaku Hoshasen Gakkai Zasshi, 27: 1064-71(Nov. 1967). (In Japanese).

Endoxan exposed to ionizing radiation was found to acquire enhanced activity for inhibition of growth of cultured human tumor cells (HeLa cells) and of colony forming ability of Escherichia coli. The enhanced activity of Endoxan was approximately in proportion to the exposure dose of radiation in the range from 5×10^4 to 3×10^5 R. The enhanced activity of Endoxan that inhibited colony formation of E. coli increased when M/15 PO_4 buffer was added prior to irradiation. The activity was most enhanced at the least concentration (2.5 to 20.0 mg/ml); dry Endoxan was least activated. The E. coli killing activity of Endoxan irradiated in solution was approximately equal to the sum of activity of irradiated dry Endoxan and of Endoxan in irradiated buffer solution. The irradiation enhancement of Endoxan activity was largely due to an indirect effect of radiation on the solvent rather than a direct effect, i.e., probably through some molecular products or free radicals of rather long half life. The active fraction of irradiated Endoxan solution was isolated by means of thinlayer chromatography. The Rf value of the active fraction was found around zero point and was different from that of nor-Nitrogen mustard. (NSA of Japan)

23474 RADIATION AND THE DETOXICATION OF CHEMICALS. Haley, Thomas J.; Koste, L. (Univ. of California, Los Angeles). Contract AT(04-1)-Gen-12. J. Pharm. Sci., 56: 1652-3(Dec. 1967).

The detoxication of benzoate and resorcinol was investigated in irradiated animals. In both instances detoxication was inhibited from the third to the seventh post-irradiation days. The common denominator for this action of x irradiation appeared to be co-enzyme A and/or its substrates. (auth)

23475 NATURE OF THE BREAKDOWN OF RNA IN X-IRRADIATED ESCHERICHIA COLI. Pecevsky, Ira; Kucan, Zeljko (Rudjer Boskovic Inst., Zagreb). Biochim. Biophys. Acta, 145: 310-20(Sept. 26, 1967).

Breakdown of ^{14}C-adenine-labeled RNA, measured as the loss of radioactivity from acid-insoluble material, began 30 min after x-irradiation of Escherichia coli and proceeded for the next 150 min at a rate proportional to the dose of irradiation. The rate of breakdown was the same for RNA synthesized before or immediately after the irradiation, while RNA synthesized 60 min later was not subjected to degradation. Analysis of cell-free extracts of irradiated bacteria by zonal centrifugation in sucrose density gradients showed a time-dependent decrease of radioactivity of 50-S and 30-S ribosomes. The material appeared in a broad peak sedimenting between 4 S and 30 S that decreased as the incubation progressed. Ribonucleic acid prepared by the phenol method from bacteria at various stages of post-irradiation incubation was also analysed by zonal centrifugation. The amount of 23-S and 16-S RNA was found to decrease at the same rate, while 4-S material was not degraded. Intermediate breakdown products of ribosomal RNA sedimented between 4-S and 16-S RNA. Final breakdown products of adenine-labeled RNA formed in mineral medium were identified as adenosine monophosphates (AMP) and guanosine monophosphates and oligonucleotides. In nutrient broth, hypoxanthine, AMP, oligonucleotides, and some free adenine were found. (auth)

23476 X-RAY-INDUCED SINGLE-STRAND BREAKS AND JOINING OF BROKEN STRANDS IN SUPERINFECTING λ DNA IN ESCHERICHIA COLI LYSOGENIC FOR λ. Boyce, Richard P.; Tepper, Marcos (Yale Univ., New Haven). Virology, 34: 344-51 (Feb. 1968).

Covalently bonded circular λ phage DNA in superinfected lysogens of Escherichia coli is converted to notched circular DNA by x irradiation at 0°. The kinetics of conversion are first order with a 1/e dose of 22 krads in the presence of O_2 and 62-krads in the presence of N_2. Greater than 50% of the notched circular DNA produced by irradiation of the superinfected cells reverts to covalently bonded circular DNA within the first five minutes upon incubation at 37°. The conversion of notched circular DNA to covalently bonded DNA occurs normally in various radiation-sensitive mutants of E. coli, including those deficient in recombination. (auth)

23477 REGULATION OF CELLULAR ANTIBODY SYNTHESIS. CELLULAR 7S PRODUCTION AND LONGEVITY OF 7S ANTIGEN-SENSITIVE CELLS IN THE ABSENCE OF ANTIBODY FEEDBACK. Moller, Goran (Karolinska Inst., Stockholm). J. Exp. Med., 127: 291-306(Feb. 1, 1968).

Transfer of spleen cells from mice immunized against sheep red blood cells (SRBC) into x-irradiated (600 R) nonimmune, syngeneic mice in the presence of antigen resulted in excessive cellular 7S production 7 days later. The number of 7S plaque-forming cells (PFC) usually exceeded 10^6 per spleen and the mean proportion varied between 1 and 70%. In occasional animals all spleen cells were producing antibodies to SRBC. Serum antibody synthesis was also excessively increased, the titers in agglutination after 2-ME treatment and in hemolysis varying between 2^{15} and 2^{25}. The generation time of the 7S PFC was found to be 9.6 hr in the secondary hosts. It seemed possible that the excessive production of 7S PFC and antibodies in the irradiated nonimmune recipients was caused by the absence of feedback inhibition of the immune response by antibody, a mechanism that would normally function to restrict antibody synthesis. This conclusion was strengthened by the demonstration that transfer of antigen-stimulated immune cells into actively or passively immunized irradiated recipients resulted in a marked suppression of cellular 7S synthesis. Serial transfers of antigen-stimulated immune cell populations in irradiated hosts resulted in an equally high number of 7S PFC during the first four transfer generations. However, after the fifth to seventh transfer generation the number of 7S PFC rapidly declined and disappeared within one to three passages. Serum antibodies and 7S PFC declined in parallel during the last transfer generations. Further passages of antigen-stimulated spleen cells lacking 7S PFC did not lead to reappearance of PFC. Thus, antigen-sensitive cells have a limited life-span and/or multiplication capacity. From the hypothesis that the 7S PFC developed by division from antigen-sensitive precursors it was calculated that 38 to 40 divisions occurred. Thus, one antigen-sensitive precursor has the potential to give rise to 10^{12} 7S PFC. (auth)

Ecology

Refer also to abstracts 23350, 23352, 23353, and 23654.

23478 (ORNL-TM-1974) INFLUENCE OF SITE FACTORS ON VEGETATION PRODUCTIVITY: A REVIEW AND SUMMARIZATION OF MODELS, DATA, AND REFERENCES. Final Technical Report, FY-1966. Van Dyne, G. M.; Wright, R. G.; Dollar, J. F. (Oak Ridge National Lab., Tenn.). Mar. 1968. Contract W-7405-eng-26; Subcontract No. 2765. 238p. Dep. CFSTI.

Information from the literature concerning the influence of site factors on indirect measures of vegetation productivity is summarized in the form of computerized tables. Eight different forms of dependent variables were utilized in the literature investigated. These included six basic measurements plus two logarithmic forms. Site index or logarithm of site index was utilized in 50 equations, height or logarithm of height of tree species in 52 equations, and the remainder of 116 equations reported included cubic foot growth, basal area, diameter at breast height, and periodic growth as dependent variables. The tabulated data show the mean, maximum, minimum, and coefficient of variation for each of the variables. Examples of variables are average height, basal area, average age, percent silt of surface, percent silt of subsoil, percent sand of surface, and percent sand of subsoil. The data are presented at this stage for preliminary checking and examination by the contributors, for subsequent analyses, and for preliminary coding prior to summarizing the data on a dimensionless basis for subsequent analyses. (H.L.W.)

23479 (ORO-2412-1) RADIATION ECOLOGY STUDIES. Progress Report, January 1966–January 1967. Platt, Robert B. (Emory Univ., Atlanta, Ga.). Contract AT(40-1)-2412. 41p. Dep. CFSTI.

An area of the Nevada Test Site in which the vegetation was damaged or killed by ionizing radiation was investigated. The radioactive material, containing both beta and gamma emitters, was deposited on the plants and soil around them. A table is presented to show relative sensitivity of plants indicated by dose rates measured where the plants were both dead and seriously damaged. The plants studied were sage (Artemisia arbuscula and A. tridentata), red cedar (Juniperus osteosperma), mormon tea (Ephedra viridis and E. nevadensis), hop sage (Grayia spinosa), and a rosaceous species (Cowania mexicana). The effects of gamma radiation and other environmental stresses on the aquatic isopod, Lirceus fontinalis, were studied. The effects of gamma radiation on osmoregulation in juvenile and adult estuarine isopods (Cyathura polita) were investigated. Studies were carried out on the effects of periodic exposure to gamma radiation upon a typical life system. The organisms studied were seedlings of Pinus sp., seeds of Phaseolus vulgaris and Raphanus sativus, and gemmae of Marchantia polymorpha. The effects of gamma radiation, climate, and nutrition on the growth and structure of the lichen, Parmelia conspersa, were studied. The relationship between distribution of saxicolous plants and microweathering and microtopography of

granite was studied. Studies on the effects of chronic gamma radiation on quantitative compositional changes in ecosystems were conducted. Results of all studies are shown by means of tables and graphs. (H.L.W.)

23480 (ORO-2412-7) RADIATION ECOLOGY STUDIES. Progress Report, January 1967-January 1968. Platt, Robert B. (Emory Univ., Atlanta, Ga.). Contract AT(40-1)-2412. 18p. Dep. CFSTI.

CRUSTACEA — Cyathura polita osmoregulation in adults and juveniles of, effects of salt concentration of sea water on
ANGIOSPERMIDAE — Triticum vulgare, radiation effects on, effects of periodic exposure on γ
GRANITES — microtopography and microweathering of, effects of distribution of saxicolous plants on
EUMYCOTA — ecology on granite outcrops of Southeastern Piedmont
NUCLEAR EXPLOSIONS — effects on secondary succession on a flood plain six years after exposure
ECOSYSTEMS — radiation effects on, at Nevada Test Site
OSTEICHTHYES — Lirceus fontinalis, radiation effects on
ECOSYSTEMS — radiation effects on composition of, on granite outcrops γ

23481 (PRNC-102) ANNUAL REPORT, 1966. (Puerto Rico Nuclear Center [Mayaguez]). Sept. 1967. Contract AT(40-1)-1833. 249p. Dep. CFSTI.

Training programs in health physics, nuclear engineering, and applications of radiation and radioisotopes in the fields of agriculture, biology, chemistry, food processing, and medicine are described. Brief summaries of results of research studies are presented. A list is included of 70 papers published during the period covered by this report. (C.H.)

23482 (TID-24291) LONG SHOT BIOENVIRONMENTAL SAFETY PROGRAM. Final Program. Seymour, Allyn H.; Nakatani, Roy E. (Washington Univ., Seattle. Lab. of Radiation Ecology). Oct. 27, 1967. Contract AT(45-1)-1385. 47p. (RL-1385-1). Dep. CFSTI.

There was no damage to any population of organisms living on or near Amchitka Island as a consequence of the Long Shot nuclear detonation. The basis for this conclusion was a census of sea otters and other wildlife; a search for dead or injured organisms immediately after the Long Shot detonation; and live-box experiments with freshwater fish, marine fish, and crabs. Also, there was no venting of radionuclides from this nuclear explosion, as indicated from the comparison of the results of γ spectrum and ^{90}Sr analyses of samples collected before and after the detonation. (auth)

23483 TAXONOMIC REVIEW: MIRIDAE OF THE NEVADA TEST SITE AND THE WESTERN UNITED STATES. Knight, Harry H. (Brigham Young Univ., Provo, Utah). Brigham Young Univ. Sci. Bull., Biol. Ser., 9: 282p.(Jan. 1968).

Approximately 5,000 specimens of plant bugs were collected at the Nevada Test Site between 1959 and 1965. Greatest emphasis was given to collecting from June 10 to 24, 1965, when the desert areas at the test site were usually profuse with blooming vegetation. A total of 160 species representing 50 genera was taken at the test site. Of these, seven genera and 96 species are new. Comparative data for these and additional species from other parts of western North America are also included. These represent an additional 449 species of which 5 genera and 148 species are new. Altogether, 612 species of 122 genera are included in taxonomic keys to the subfamilies, genera, and species of western North America, including a total of 245 new species. Distribution data are provided for each species, and host plant relationships are designated when known. (auth)

Genetics and Cytogenetics

Refer also to abstracts 23410, 23457, 23481, 23580, 23645, 23676, 23678, and 23689.

23484 (COO-1512-5) APPLICATION OF BIOMETRICAL GENETIC TECHNIQUES TO IRRADIATED AND NON-IRRADIATED POPULATIONS OF CORN TO PROVIDE INFORMATION ON NATURE OF GENE ACTION INVOLVED IN THE INHERITANCE OF QUANTITATIVE TRAITS AND IN HETEROSIS. Technical Progress Report, 1967-68. Gardner, C. O. (Nebraska Univ., Lincoln. Dept. of Agronomy). Feb. 20, 1968. Contract AT(11-1)-1512. 27p. Dep. CFSTI.

ANGIOSPERMIDAE — Zea mays, radiation effects on grain yield of, thermal neutron and x; Arabidopsis sp., radiation effects on seeds of, thermal neutron and x
COMPUTER PROGRAMS — development for calculation of genetic variability in populations of corn
GENES — effects on populations of corn
BIOLOGICAL MODELS — development for determining breeding value of corn
NEUTRONS, THERMAL — effects on homozygous lines of corn, effects of seed exposure on
ULTRAVIOLET RADIATION — effects on homozygous lines of corn, effects of pollen exposure on
POPULATIONS — radiation effects on genetics of, in corn, thermal neutron
METHANESULFONIC ACID, ETHYL ESTER-, — effects on genetic variability in corn
ALCOHOL DEHYDROGENASE — activity in seeds of corn (H.L.W.)

23485 (COO-1512-6) APPLICATION OF BIOMETRICAL GENETIC TECHNIQUES TO IRRADIATED AND NON-IRRADIATED POPULATIONS OF CORN TO PROVIDE INFORMATION ON NATURE OF GENE ACTION INVOLVED IN THE INHERITANCE OF QUANTITATIVE TRAITS AND IN HETEROSIS. Comprehensive Summary Report, 1965-68. Gardner, C. O. (Nebraska Univ., Lincoln. Dept. of Agronomy). Feb. 20, 1968. Contract AT(11-1)-1512. 7p. Dep. CFSTI.

Thermal neutrons, x rays, and EMS were used as mutagenic agents to induce favorable mutations for population improvement. Biometrical genetic models coupled with appropriate mating designs were used to study many different kinds of populations. Sets of homozygous lines, random mating populations, improved selected populations, and hybrid populations were studied, and data were collected on a number of quantitative traits. A study was conducted to determine the effect of irradiation and selection on the frequency of deleterious recessive alleles. Results indicated that selection did not reduce the frequency of such alleles suggesting that the frequency of any one allele was probably quite low in the population and that there were a number of loci involved in the chlorophyll deficient seedlings observed. On the other hand, the irradiation treatments increased the number of families having chlorophyll deficiencies. (H.L.W.)

23486 (LF-38, pp 73-8) CYTOGENETIC EFFECTS OF ^{90}Sr ON THE BONE MARROW OF CHINESE HAMSTERS. (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.).

Chinese hamsters were given intraperitoneal injections of 0.2 to 5 μCi of ^{90}Sr/gm body weight and killed at 2 or 14 days post-injection to evaluate the cytogenetic effects of ^{90}Sr in bone marrow. At both 2 and 14 days post-injection doses of 3 μCi or less per gram resulted in mitotic indices that were greater than or equal to the controls. At both time-periods, there was a dose-related increase in the frequency of chromosome breaks per cell. When related to the cumulative absorbed β-dose to skeleton over the observation period, values of 0.0005 and 0.0001 breaks/cell/Rad were calculated for the 2- and 14-day post-injection hamsters, respectively. (auth)

23487 (ORO-2976-14) GENETIC AND CYTOGENETIC ANALYSIS OF THE EFFECTS OF RECURRENT IRRADIATION AND CHEMICAL MUTAGENS ON GENERAL AND SPECIFIC COMBINING ABILITY IN PEARL MILLET, PENNISETUM TYPHOIDES. Progress Report, May 1, 1967-April 30, 1968. Burton, Glenn W.; Powell, Jerrel B. (Georgia Univ., Tifton. Georgia Coastal Plain Experiment Station). Contract AT(40-1)-2976. 59p. Dep. CFSTI.

The effect of thermal neutrons and EMS on combining ability in pearl millet was analyzed, mating and testing systems were evaluated, the second cycle of a new mutagen series of treatments were given, and the effects observed. Data collected this year and the variance components computed from 3 × 3 singlecross diallel matings, using a 9 × 9 lattice-square design, show the most promise of providing meaningful combining-ability evaluations. The experimental procedures developed were a compromise between greater numbers of plants screened at lower levels of precision for combining-ability detection and fewer plants at higher levels of precision for detection of combining ability. Experience gained using cytoplasmic male sterile inbreds as female testers of single plants suggested that this procedure holds considerable promise. The second-cycle application of a new mutagen treatment series produced responses similar to those of the first cycle. The high thermal neutron dosage, combined with diethyl sulfate or EMS, continued to produce the higher mutation rates for chlorophyll-deficient seedlings. The diversity of distinct types of chlorophyll-deficient seedling mutations in pearl millet are numerous. Steps are being taken to preserve this wealth of genetic variability. (auth)

23488 (ORO-2976-15) GENETIC AND CYTOGENETIC ANALYSIS OF THE EFFECTS OF RECURRENT IRRADIATION

AND CHEMICAL MUTAGENS ON GENERAL AND SPECIFIC COMBINING ABILITY IN PEARL MILLET, PENNISETUM TYPHOIDES. Three-Year Review, May 1, 1965–April 30, 1968. Burton, Glenn W.; Powell, Jerrel B. (Georgia Univ., Tifton. Georgia Coastal Plain Experiment Station). Contract AT(40-1)-2976. 17p. Dep. CFSTI.

Effects of thermal neutron dosage and EMS treatments on inbred lines of millet were studied. Results gave information on mutability of those loci associated with chlorophyll-deficient seedlings. The knowledge of treatment response ensured the selection of inbreds and treatments after three cycles that were potentially different in regard to small genetic changes. No gross morphological mutants were retained for combining-ability tests. Obvious mutants, such as golden, early maturity, and dwarfing, would be expected to have some effect on combining ability. The purpose in these initial studies was to search for subtle changes in heredity that might have significant changes in combining ability. To increase the frequency of these changes, recurrent thermal neutron and chemical treatments were given. Five inbred lines were advanced through two cycles of mutagen treatments. Mutation rates were increased by combining thermal neutron treatments with chemical treatments with little reduction in physiological vitality. A cytological analysis was made of the frequencies and types of chromosome aberrations resulting from thermal neutron irradiation and chemical mutagen treatment. It is pointed out that mutants related to cytological aberrations contribute to an understanding of basic cytogenetic mechanisms and their relation to the expression of combining ability. (H.L.W.)

23489 (RLO-353-21) BARLEY CYTOGENETICS AND BREEDING. Progress Report. Nilan, R. A.; Powell, J. B.; Conger, B. V.; Muir, C. E. (Washington State Univ., Pullman. Dept. of Agronomy). Aug. 1967. Contract AT(45-1)-353. 11p. (CONF-670942-3). Dep. CFSTI.

From FAO/IAEA Panel on Induced Mutations in Plant Breeding, Meeting, Vienna, Austria.

MUTAGENS—effects on chromosome recombinations and inversions in barley

MUTATIONS—induced in barley by chemical and physical agents

ANGIOSPERMIDAE—Hordeum vulgare, radioinduced mutations in, efficiency of (H.L.W.)

23490 EFFECTS OF IONIZING RADIATION ON CHROMOSOMES OF PLANTS AND MAMMALS. Sokolov, N. N.; Sidorov, B. I.; Demin, Yu. S.; Itsyna, N. A. Izv. Sib. Otd. Akad. Nauk SSSR, Ser. Biol.-Med. Nauk, No. 5, 124-31(Apr. 1967). (In Russian).

A comparison was made of the spectrum of single-collision chromatid cross-over in the cells of plants and mammals after the effects of ionizing radiztion. The data obtained indicated that in mammal cells the frequency of single terminal divisions significantly exceeded the frequency of isologous breaks in plant cells. There was a difference in behavior of destroyed tips in cells of plants and mammals of chromatids and the number of compounds formed in plant cells were more than those in mammalian cells. The difference could be connected either with the molecular characteristics of the mechanism of the break of chromosome threads, or with the differences in the physiological activity of the plant and mammal cells. (tr-auth)

23491 ANALYSIS OF THE CHANGE OF THE RADIOSENSITIVITY OF HeLa CELLS DURING THEIR IRRADIATION WITH GAMMA RAYS AT DIFFERENT TIMES AFTER SEEDING. Barsukov, V. S.; Malinovskii, O. V.; Sheikina, T. A. Izv. Sib. Otd. Akad. Nauk SSSR, Ser. Biol.-Med. Nauk, No. 5, 100-8(Apr. 1967). (In Russian).

From changes in the form of the dose-survival curves, conclusions could be made on the relation of the percentage survival, after irradiation at two different doses, in the threshold region of the curve. The change in the form of the dose-survival curve for single HeLa cells, during transition of the population from the threshold log-phase state to the logarithmic phase of growth, could be satisfactorily explained by a decrease of the lifetime of the single open break of the chromosome and decrease in the probability of the lethal double impact chromosome cross-over. (tr-auth)

23492 EFFECT OF INDUCTIVE MUTATIONS IN HETEROZYGOTE STATE ON THE VIABILITY OF ORGANISMS. Vorobtsova, I. E.; Gol'zberg, K. L.; Yur'eva, N. A. Izv. Sib. Otd. Akad. Nauk SSSR, Ser. Biol.-Med. Nauk, No. 5, 85-94(Apr. 1967). (In Russian).

On two radiosensitive lines of Drosophila P-86 and Canton-C a negative effect of the burden of inductive mutations in the heterozygote state on the viability of organisms in normal conditions and with supplementary burden was observed. The damaging effect of this mutation was apparent in almost all stages of ontogenesis of the fly. The character of the phenomenon of inductive mutation in the heterozygote state in the radiosensitive lines of foreign strains was indicated by the contrasting observance in the P-86 and Canton-C lines. Hypotheses were made and experimentally verified that the inter-line differences in the character of the phenomenon of mutations was connected with dissimilar degrees of heterozygote state of the lines studied. (tr-auth)

23493 DOSE-EFFECT RELATIONSHIP OF AUTOSOMAL TRANSLOCATIONS INDUCED BY X-RAYS IN MATURE OOCYTES OF DROSOPHILA MELANOGASTER. Traut, H. (Univ., Muenster, Ger.). Int. J. Radiat. Biol., 12: 583-6(1967).

Radioinduced translocations between Drosophila melanogaster autosomes 2 and 3 were scored genetically with the aid of markers. The offspring scored were derived mainly from Stage 14 oocytes. X-ray doses of 250, 500, 750, and 1000 R were used. The maximum frequency of 2:3 translocations observed was 0.36%. Above 250 R the dose-effect curve departed from a linear relation and became saturated. (M.M.B.)

23494 CYTOGENETIC CHANGES FOLLOWING THOROTRAST ADMINISTRATION. Buckton, Karin E.; Langlands, A. O.; Woodcock, Gillian E. (Western General Hospital, Edinburgh). Int. J. Radiat. Biol., 12: 565-77(1967).

The results are given of a cytogenetic study on 36 patients who had received Thorotrast by intra-arterial injection from 11 to 31 years previously. Unstable chromosome damage was found in 9.2% of the cells examined; many cells contained more than one aberration, and 3.8 tricentrics were found per 100 cells analysed. No correlation was found between the numbers of unstable aberrations or the estimated number of chromosome breaks and either the volume of Thorotrast given or the number of years which had elapsed since its administration. Reasons for this lack of correlation are discussed. When the mean values for males and females were compared there appeared to be no sex difference. 5.7% of cells examined contained only stable chromosome rearrangements. In two patients cells containing the same chromosome re-arrangement were found on separate occasions and in sufficient numbers to indicate their origin from lymphocyte clones in the peripheral blood of these individuals. (auth)

23495 GIANT CELLS OF ESCHERICHIA COLI. Adler, Howard I.; Terry, Claude E.; Hardigree, Alice A. (Oak Ridge National Lab., Tenn.). J. Bacteriol., 95: 139-42(Jan. 1968).

A mutant strain of Escherichia coli K-12 produced amorphous cells when grown in a variety of media. The lon⁻ allele known to increase the radiation sensitivity of the cytokinesis mechanism, was introduced into the mutant by means of conjugation. Cells of this recombinant strain grew, after exposure to radiation, into giant amorphous cells, approximately 500 to 1,000 times the volume of a normal E. coli cell. These giant cells are analogous to the filaments formed after the irradiation of lon⁻ rod-shaped cells. (auth)

23496 GLUCOSE-6-PHOSPHATASE DEFICIENCY CAUSED BY RADIATION-INDUCED ALLELES AT THE ALBINO LOCUS IN THE MOUSE. Erickson, Robert P.; Gluecksohn-Waelsch, Salome; Cori, Carl F. (Albert Einstein Coll. of Medicine, Bronx, N. Y. Massachusetts General Hospital, Boston). Proc. Nat. Acad. Sci. U. S., 59: 437-44(Feb. 1968).

Four x radiation-induced alleles at the albino locus of the mouse produced in homozygotes, in addition to absence of pigmentation, abnormalities of thymus and kidneys, and deficiency of glucose-6-phosphatase. The resulting hypoglycemia accounted for death of newborn mice within a few hours after birth. The mutations are considered to be chromosomal deficiencies including a genetic region that controls enzymes involved in melanin formation and in glycogen metabolism. (auth)

23497 MINIATURE CENTRIC FRAGMENT CHROMOSOMES IN MUTAGEN-TREATED PEARL MILLET, PENNISETUM TYPHOIDES. Powell, Jerrel B.; Burton, Glenn W. (Univ. of Georgia, Tifton). Contract AT(40-1)-2976. Crop Sci., 6: 590-3 (Nov.-Dec. 1966).

A miniature centric-fragment chromosome was observed in pearl millet, Pennisetum typhoides (Burm.) Stapf and C. E. Hubb., subjected to thermal neutron and ethyl methane sulfonate treatments. The very small chromatic particles oriented themselves at the metaphase I plate, and divided and moved to the poles at anaphase I, but were irregular in their behavior at anaphase II. Most plants with these centric-fragment chromosomes were found in the thermal neutron treatments, with some in the ethyl methane sulfonate treatments, but none in the controls. One miniature centric-fragment chromosome was the most common number present in microsporocytes of single plants, with the exception of one plant which contained two fragment chromosomes per cell.

Size variation in the particles was noted in one plant. These miniature centric-fragment chromosomes, discovered in mutagen-treated pearl millet, may have an origin similar to the small ring chromosomes described in maize. (auth)

23498 MORPHOLOGICAL AND CYTOLOGICAL RESPONSE OF PEARL MILLET, PENNISETUM TYPHOIDES, TO THERMAL NEUTRON AND ETHYL METHANE SULFONATE SEED TREATMENTS. Burton, Glenn W.; Powell, Jerrel B. (Univ. of Georgia, Tifton). Contract AT(40-1)-2976. Crop Sci., 6: 180-2(Mar.-Apr. 1966).

Three dosages each of thermal neutrons (TN) and ethyl methane sulfonate (EMS) were applied to 10 pearl-millet inbreds evaluated in replicated plots in the field. Both mutagens delayed seedling emergence and days to maturity, and reduced seedling height, plant height, leaves per culm, and self-fed and sibbed seed set. EMS reduced percent emergence and plants per plot to reach maturity. This extra space allowed EMS-treated survivors to produce more culms and yield more. Two-thirds of the 56 sectorial mutants came from TN-treated seed. Significant inbred × treatment interactions were obtained for 5 of 13 characters studied. Frequencies of chlorophyll-deficient seedlings from self-fed seed of all plants indicated that the 90-minute TN treatment and 0.4% EMS soak for 4 hours, increased the average mutation frequency most (some 5 fold). Mutation frequency in inbreds varied greatly. The most effective EMS treatment induced over 8 times as many mutants in 1 inbred as in another. The 90-minute TN treatment produced 4 times as many plants (28%) with chromosome interchanges as the heaviest EMS treatment. (auth)

23499 THE ITACONIC AND ITATARTARIC ACID FORMATION BY UV- AND GAMMA-IRRADIATED ISOLATES OF ASPERGILLUS TERREUS NRRL 1960. Jakubowska, Jadwiga; Oberman, Helena; Makiedonska, Alina; Florianowicz, Teresa (Technical Univ., Lodz). Acta Microbiol. Pol., 16: 53-68 (1967).

Mutants producing increased amounts of the acids were produced by irradiation. By use of a S-300 Hanau lamp at a distance of 30 cm, uv irradiation of a conidial suspension lasting for 4 min was found to be lethal for 99% of conidia. This irradiation time was used to obtain an active mutant. With ^{60}Co γ irradiation the lethal dose for conidia of A. terreus NRRL 1960 was 3×10^5 Rad. The survival curve showed that 72×10^3 Rad was lethal for 99% of irradiated conidia. This dose was used to obtain high level acid-producing mutants. About 750 isolates were thus obtained by uv and γ irradiation. They were examined for acid production on the Lockwood–Ward medium. Two active strains were chosen for further studies: the uv mutant N 17 and the γ-ray mutant N 22/IV. The distinctly higher acid-producing activity of both mutants was stable during 1 yr of cultivation. The greater itaconic acid formation was correlated with lower mycelial weight. The production of organic acids by these mutants was measured chromatographically over a 19-day fermentation period. The acid-producing ability of the strains was not changed by repeated uv and γ-ray treatment. (BBB)

23500 NOVEL CHARACTER INDUCED IN YEAST BY ^{32}P DECAY: THE ABILITY TO MANIFEST HIGH FREQUENCIES OF ABNORMAL MEIOTIC SEGREGATIONS. Moustacchi, E.; Hottinguer-de-Margerie, H.; Fabre, F. (Institut du Radium, Orsay, France). Genetics, 57: 909-18(Dec. 1967).

A high proportion of haploid yeast cells surviving heavy labeling with ^{32}P have a novel character referred to as AM that results in abnormal meiotic segregations. When an AM cell is crossed with a normal strain (am), and the resultant hybrid is sporulated, 4+: 0, 3+: 1– and 2+: 2– ratios are found for the nutritional markers introduced in the cross. Most of the segregants have a DNA content higher than either haploid parent and are capable of sporulation. A tetraploidization of the hybrid during vegetative growth seems unlikely. More probably an extra duplication of the genetic material during meiosis, controlled by AM, may be responsible for the abnormal segregations. (auth)

23501 ANOMALOUS RADIOBIOLOGICAL PHENOMENON. Avakyan, Ts. M.; Semerdzhyan, S. P.; Oganesyan, Dzh. (Scientific Research Inst. of Agriculture, Echmiadzin, USSR). Radiobiologiya, 7: 935-7(1967). (In Russian).

Pea seeds were irradiated at doses of 12, 15, and 20 kR at a dose rate of 600 R/min. Histological analyses were conducted on rootlets of seed that were steeped for one day in distilled water and allowed to grow for two days in moist sand at 23°C. Chromosome aberrations were calculated on 200 anaphases. There was a direct dependence of aberrations on dose up to 15 kR. At 20 kR, the percentage of aberrations decreased. The mitotic activity decreased at doses of 12 and 15 kR; at 20 kR, it was the same as that of the nonirradiated samples. (JPRS)

Health Physics and Safety

Refer also to abstracts 23084, 23165, 23169, 23170, 23190, 23262, 23270, 23588, 23650–23652, 23673, and 24749.

23502 (BNWL-SA-683) MODEL DEVELOPMENT AND SIMULATION OF THE TRANSLOCATION OF RADIONUCLIDES IN MAMMALS. Dionne, P. J.; Harvey, R. A.; Watson, E. C. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). May 11, 1966. Contract AT(45-1)-1830. 31p. (CONF-660568-1). DTIE.

From Joint Conference of the Northwest Simulation Council and IEEE Professional Technical Group Engineering in Medicine and Biology, Seattle, Wash.

An analog computer model for appraisal of internal exposure following an accidental release of radionuclides is described. The model computes organ burdens for the parent radionuclide and its first daughter and expansion to include a second daughter is possible. The model contains 13 individual compartments that represent the four segments of the gastrointestinal tract, lungs, skin, blood, kidney, thyroid, mammary gland, bone, muscle, and liver. Other organs may be represented by substituting values for the appropriate parameters or by adding compartments. An example of the use of the model is given for determining ^{65}Zn organ burdens in the human body following ingestion of contaminated oysters from the Pacific coast. A lung model is described for determining clearance of inhaled dusts. The mathematical model selected for this study is based on the assumption that the rate of change of the quantity of a radionuclide within an organ or tissue is equal to the amount of radionuclide entering minus the amount of radionuclide leaving that organ or tissue. Graphical solutions of analog simulation of translocation of radionuclides are given for $^{132}Te - ^{132}I$ in man following ingestion of ^{132}Te. The accumulation of ^{132}I and its subsequent distribution with time in various organs of the body is shown graphically. Other diagrams, graphs, and equations are presented to show analog simulation of translocation of radionuclides. (H.L.W.)

23503 (BNWL-SA-1540) PLUTONIUM INHALATION MODEL SIMULATES THE LONG-TERM BURDENS OF THE DEEP LUNG AND SYSTEMIC ORGANS. Dionne, Paul J.; Stuart, Bruce O. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Mar. 1, 1968. Contract AT(45-1)-1830. 23p. (CONF-680502-1). Dep. CFSTI.

From 6th IEEE Region Conference, Portland, Ore.

The dynamic simulation of plutonium buildup and elimination from the major organs of the body after plutonium dioxide inhalation was developed from tissue radioanalyses and excretion data from beagle dogs that were sacrificed from two months to six and one-half years after inhaling $^{239}PuO_2$ aerosols. The model's description of individual tissue contents as functions of time after exposure were fitted to the analyzed plutonium burdens obtained from over fifty dogs, providing insight into several problems connected with inhaled insoluble plutonium. Thus, it was found that changing the combined initial depositions in the nasopharynx tracheo-bronchial region, plus fast pulmonary regions, from 70% to 90%, had comparatively little effect on the long-term burdens of plutonium in the liver, bone, and kidneys. The rapid initial peak in the blood compartment suggests that much earlier blood sampling is needed as well. The use of a model based on the slow pulmonary compartment appears to be justified in the study of effects on systemic organs and the lymphatic system. The model was programmed for a UNIVAC 1108 digital computer using a digital simulation language. (C.H.)

23504 (HW-76823) RADIOLOGICAL CHEMISTRY ASSOCIATED WITH THE HANFORD CRITICALITY OF APRIL 7, 1962. Perkins, R. W.; Kirby, L. J. (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). Oct. 1, 1962. Contract AT(45-1)-1350. 26p. DTIE.

A critical accident occurred at the Hanford Atomic Products Operation on April 7, 1962 during which three men received radiation doses exceeding two rads. The radiochemical and bioassay measurements in connection with the accident are reported. Blood ^{24}Na measurements and whole-body counting provided the primary and early information on the neutron exposure. Measurements of the ^{32}P in hair produced by the ^{32}S (n,p) ^{32}P reaction provided information for estimating the fast neutron dose at various locations on the individuals. Additional information on the neutron exposure was obtained from measurements of the induced radionuclides in the silver absorbers from the personal dosimeters and in the employees' personal effects. The time-integrated neutron flux to which these objects were exposed was determined by re-exposing these objects to a known slow neutron flux in the moderator of a Van de Graaff accelerator and re-measuring the induced radionuclides. The ^{24}Na elimination in

urine and feces samples was determined from measurements made for several days after the incident and was compared with the neutron doses received. The release of the short lived fission product ^{138}Cs (32.2 min) from the building ventilation-exhaust system served as a monitor of the relative rate of the continuing fission process in the criticality vessel. Measurements of fission products in the criticality vessel after the incident indicated that a total of about 10^{18} fissions had occurred. (auth)

23505 (LF-38, pp 103-7) MULTI-DETECTOR SYSTEM FOR MONITORING AIRBORNE BETA EMITTING RADIONUCLIDES. (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.).

A system for monitoring airborne beta-emitting radioactive particulates was developed and is described. Using up to 16 remote scintillation detectors, the airborne contamination may be monitored in several areas of a building. The central control and readout console may either accumulate and display data from the several detectors or continuously monitor a selected area of potentially high contamination. The efficiencies for selected beta-emitting radionuclides range from 26 to 54%. (auth)

23506 (NP-17328) MEDICAL X RAY AND GAMMA RAY PROTECTION FOR ENERGIES UP TO 10 MeV: EQUIPMENT DESIGN AND USE. (National Council on Radiation Protection and Measurements, Washington, D. C.). Feb. 1, 1968. 66p. (NCRP-33). NCRP Publications, Washington, D. C. $0.75.

Recommendations for protection against radiation emitted by medical x-ray equipment operating at energies up to 10 MeV and medical gamma-beam therapy equipment are presented. Equipment design, use, and operating conditions and radiation protection surveys and personnel monitoring are considered. (W.H.K.)

23507 (PRWRA-GNEC-7(Rev.2)) RADIATION PROTECTION STANDARDS. Bonnet, Juan A. Jr. (Puerto Rico Water Resources Authority, Rincon. Bonus Nuclear Power Station). May 1967. Contract AT(40-1)-2672. 187p. Dep. CFSTI.

The practices and regulations to be followed during operation of the BONUS plant for radiation protection are discussed. Topics include responsibilities of health physics personnel, radiation and contamination limits, maximum permissible concentrations in air and water, operating regulations, plant restrictions, routine operations, emergency procedures and facilities, instruments and equipment, and records and reports. (B.G.D.)

23508 (SC-M-67-2973) PULMONARY RADIOTOXICOLOGY. Bruner, H. D. (Division of Biology and Medicine (AEC), Washington, D. C.). Dec. 1967. 21p. (CONF-670956-1). Dep. CFSTI.

From Biological Science Symposium, Albuquerque, N. Mex.

For Sandia Corp., Albuquerque, N. Mex.

The contamination of the respiratory system by fine radioactive particles is discussed. Possible sources of radioactive particles in the atmosphere include reactors used to generate power, research reactors, the manufacture of reactor fuel elements, the processing of spent fuel, particles suspended in the atmosphere by past atmospheric testing, and reentry burn-up of isotopic power units of various SNAP devices. Standards for the maximum permissible concentration of radioactive isotopes in air established by the International Commission on Radiological Protection and the National Council on Radiological Protection, and their value for the radiation protection of personnel in nuclear industry and the public are discussed. Problems encountered in the production of stable, reproducible aerosols and in measurements of the number and size of particles in the aerosol used for research studies are discussed. It is pointed out that the biophysical principles governing movement of various sizes of particles in the respiratory system and the radiation dosimetry of aerosols are very complex. The value of NaI(Tl) crystal detectors in pulmonary radiotoxicology is discussed. Research programs in pulmonary radiotoxicology sponsored by the Atomic Energy Commission are reviewed briefly. It is concluded that, although the science of pulmonary radiotoxicology is well advanced, additional experimental and theoretical studies in this field are needed. (C.H.)

23509 (SC-CR-67-2729) RADIOLOGICAL SAFETY STUDIES OF SPACE NUCLEAR SYSTEMS. Fourth Quarterly and Final Report. Coleman, James R.; Perez, Lawrence J. Jr. (NUS Corp., Washington, D. C.). Oct. 1967. Contract AT(29-1)-789; Subcontract 48-4310. 270p. Dep. CFSTI.

For Sandia Corp., Albuquerque, N. Mex.

A mathematical description of the significant pathways by which man might become adversely affected from an unwanted release of SNAP fuel is presented. Developments and applications for determining radiation doses with interaction probabilities are presented for both intact and dispersed re-entry modes of isotopic SNAP units using ^{210}Po, ^{147}Pm, ^{238}Pu, ^{90}Sr, or ^{171}Tm. The models presented reflect varying degrees of thoroughness with more effort exhibited on those areas considered to be the most important at this time. For example, the probabilistics associated with the lung organ dose model were thoroughly studied and presented in great detail. This was done because the fuel forms currently under consideration pose a significant hazard to the pulmonary compartment, that appears to be critical in the evaluation of the hazards. The models included herein are: internal organ dose for inhalation and ingestion, skin dose from direct deposition on the skin surface, whole body dose from a field of deposited material, resuspension of ground deposited particles, contamination of vegetation and meats, surface water transport, and overall mission interaction probability model for intact re-entry. (auth)

23510 (UCRL-70787) ESTIMATION OF DOSAGE TO THYROIDS OF CHILDREN IN THE U. S. FROM NUCLEAR TESTS CONDUCTED IN NEVADA DURING 1952 THROUGH 1955. Tamplin, Arthur R. (California Univ., Livermore. Lawrence Radiation Lab.). Nov. 14, 1967. Contract W-7405-eng-48. 46p. (CONF-671208-3). Dep. CFSTI.

From 134th Annual Meeting of the American Association for the Advancement of Science, New York.

Estimates of the thyroid dosage accumulated by children up to five years of age in the United States as a result of nuclear weapons tests in Nevada during 1952 through 1955 (Tumbler-Snapper, Upshot-Knothole, and Teapot Series) are presented. It is pointed out that these are only estimates of the dosage, based upon the assumptions that cow milk was the sole source for transfer of ^{131}I to children, that the average child drank 1 liter of milk per day, and that the cows were on pasture at the time of contamination. It is suggested that if a heavy rainout of radioactivity occurred on the area of their pasture, some children consuming milk from their family cow could have exceeded this average dosage by a factor of 10. (C.H.)

23511 (UCRL-70788) IMPLICATIONS OF THE UTAH SITUATION FOR FUTURE USES OF NUCLEAR ENERGY. Ng, Yook C. (California Univ., Livermore. Lawrence Radiation Lab.). Nov. 14, 1967. Contract W-7405-eng-48. 50p. (CONF-671208-2). Dep. CFSTI.

From 134th Annual Meeting of the American Association for the Advancement of Science, New York.

The extensive coverage given to infant thyroid radiation doses in Utah caused by ^{131}I subsequent to nuclear device testing at the Nevada Test Site is sufficient evidence to indicate that both preshot prediction and postshot documentation of the dosage to humans from internal emitters was inadequate. In the planning of future events that could involve the release of radioactivity to the biosphere, both the preshot radiation safety analysis and the postshot documentation must be adequate to ensure the public health and safety. An approach was developed for preshot prediction of dosages that was designed to meet these requirements. As an example of this approach the method for estimating the maximum internal dose that could result from the deposition of radioactive fallout at sites distant from the origin is described in detail. The analysis considers each radionuclide that could be produced in nuclear detonations and identifies those that could contribute most to the internal radiation dose following entry into food chains and consumption by man. The analysis provides an estimate of the maximum internal dose and of the contributions of individual radioisotopes to this dose. The calculations required to estimate the maximum whole-body dose from underground nuclear explosions are presented to illustrate the method. (C.H.)

23512 (LA-tr-68-12) POTENTIAL RADIATION HAZARD IN RADAR INSTALLATIONS. Koerner, H.-J. Translated for Los Alamos Scientific Lab., N. Mex., from Zentralbl. Arbeitsmed. Arbeitsschutz, 17: 1-5(1967). 12p. Dep. CFSTI. JCL $1.60 fs, $0.80 mf.

High-frequency radiation emitted by the transmitter antenna and ionizing radiation emanating from some tube types used in radar installations are examined. Preventive and monitoring safety measures are discussed. (W.H.K.)

23513 PROPOSED RADIOACTIVITY CONCENTRATION GUIDE FOR SHELLFISH. Weaver, C. L. (National Center for Radiological Health, Washington, D. C.). Radiol. Health Data Rep., 8: 491-4(Sept. 1967).

The recommendations of the International Commission on Radiological Protection (ICRP), the National Committee on Radiation Protection (NCRP), and the Federal Radiation Council (FRC), were applied in deriving proposed guides for radioactivity in shellfish. FRC Report No. 1 presents basic exposure criteria, FRC Report No. 2 presents intake guides for ^{89}Sr, ^{90}Sr, ^{131}I, and ^{226}Ra, and NCRP and ICRP provide data on the maximum permissible con-

centrations of radioisotopes in water. The proposed guide was assembled by the National Center for Radiological Health in collaboration with the Water Supply and Sea Resources Program of the National Center for Urban and Industrial Health, Public Health Service. (auth)

23514 RADIOACTIVITY IN THE MEXICAN ENVIRONMENT. Nulman, R. M.; Vasquez Barete, M. (Comision Nacional de Energia Nuclear, Mexico City). Radiol. Health Data Rep., 8: 495-501(Sept. 1967).

The Comisión Nacional de Energia Nuclear in Mexico operates surveillance networks monitoring radioactivity in airborne particulates, particulates in fallout and precipitation, drinking water, milk, food, and sea water. Methods of analysis and the resultant data for 1965 and 1966 are presented. This surveillance program was instituted to provide a general picture of the radioactivity levels in the Mexican environment, protection for the Mexican people from overdoses of radiation, and information for the handling of legal claims that may arise against the Nuclear Center of Mexico (now under construction). (auth)

23515 DATA. Radiol. Health Data Rep., 8: 503-63(Sept. 1967).

The ^{89}Sr, ^{90}Sr, ^{137}Cs, ^{131}I, and ^{140}Ba content of milk samples collected by national and international surveillance agencies in North America and Pan America during May, 1967 is reported, and the California, Oregon, and Washington state surveillance agencies report the radioisotope content of local milk samples during Jan. to March, 1967. Data are given on the ^{90}Sr content of the human diet in New York City, San Francisco, and Chicago during Aug. to Dec., 1966. Gross radioactivity levels in surface waters of the United States during March, 1967 and ^{90}Sr levels in New York surface waters during 1966 are given. Radioactivity levels in general in airborne particulates and precipitation in North America and Pan America during May 1967, and specifically ^{90}Sr in North America during July to Dec., 1966 and ^{238}Pu, ^{239}Pu, and ^{240}Pu content in the atmosphere of the United States during Jan. to March, 1967 are presented. Data are presented on the ^{90}Sr content of human bone in the United States during Oct. to Dec., 1966. Three technical notes are presented concerning environmental radioactivity in woods soil from New Jersey during 1964 to 1966, ^{137}Cs content of some residents of Cincinnati during 1964 to 1967, and changes in ^{238}Pu and ^{239}Pu content in ground level air. The Atomic Energy Commission published data on environmental radioactivity levels of its installations including Argonne National Laboratory, National Reactor Testing Station, Portsmouth Area, and Savannah River Plant during July to Dec., 1966 and announced three underground nuclear tests at its Nevada Test Site during Aug., 1967. (E.R.B.)

23516 SUMMARY OF ^{137}Cs AND ^{90}Sr CONCENTRATIONS REPORTED IN CERTAIN ALASKAN POPULATIONS AND FOODSTUFFS, 1961–1966. Chandler, R. P.; Snavely, D. R. (Radiation Surveillance Center, Washington, D. C.). Radiol. Health Data Rep., 7: 675-89(Dec. 1966).

Published data on ^{137}Cs and ^{90}Sr content of certain Alaskan populations and foodstuffs, along with food consumption data, are reviewed and summarized. Where possible, content of diet and people are compared to FRC guidelines. The seasonal and yearly trends of ^{137}Cs and ^{90}Sr of the diet of Alaskan populations and of people are discussed. (auth)

23517 ^{137}Cs BODY BURDENS IN ALASKAN MEN, SPRING 1966. Fitzpatrick, D. E. P. (Public Health Service, Washington, D. C.); Russell, J. L.; Briscoe, O. G.; Calvert, C. R. Radiol. Health Data Rep., 7: 691-6(Dec. 1966).

The ^{137}Cs body burdens of caribou-eating Alaskan men continue to be elevated, although in general the average body burdens are decreasing compared to those observed in 1965. Elevated ^{137}Cs body burdens are well correlated with caribou (reindeer) consumption, and non-caribou eaters exhibit ^{137}Cs body burdens similar residents in the conterminous United States. During the 1966 study, the ^{137}Cs body burden of a total of 418 Alaskan men was obtained. The body burdens observed ranged from 2,400 to less than 40 nCi and indicated a wide range of values depending on location. (auth)

23518 DATA. Radiol. Health Data Rep., 7: 697-737(Dec. 1966).

The ^{89}Sr, ^{90}Sr, ^{137}Cs, ^{131}I, and ^{140}Ba content of milk in North America and Pan America during August, 1966 is reported by the national and international surveillance networks, and the California, Oregon, and Washington Milk Surveillance Networks report the ^{40}K, ^{89}Sr, ^{90}Sr, and ^{137}Cs content of local milk samples during April to June, 1966. The ^{90}Sr and ^{137}Cs content of the total human diet of the United Kingdom is reported for 1965, and the ^{90}Sr content in the diet of New York City, San Francisco, and Chicago is reported for Feb. to April, 1966. Gross radioactivity levels in surface waters of the United States are reported for June, 1966, and the ^{90}Sr content of tap water in New York City during Nov., 1965 to June, 1966 is presented. Gross beta-radioactivity levels in airborne particulates and precipitation in North America and Pan America during August, 1966 are given. The ^{90}Sr content of human bone during Oct. to Dec., 1965 and of human vertebrae during 1965 are given. The Atomic Energy Commission publishes the environmental radioactivity data for its sites at Brookhaven National Laboratory, and Rocky Flats Plant, and announces three underground nuclear tests at its Nevada Test Site during Nov., 1966. (E.R.B.)

23519 A SUMMARY OF EXPOSURES TO THE OFFSITE POPULATION AS A RESULT OF NUCLEAR REACTOR TESTS CONDUCTED AT THE NUCLEAR ROCKET DEVELOPMENT STATION DURING 1965. Oakley, Donald T. Radiol. Health Data Rep., 8: 1-4(Jan. 1967).

A summary of whole-body and thyroid exposures resulting from five nuclear reactor experiments conducted at the Nuclear Rocket Development Station during 1965 is presented. The exposures are compared with protection standards and it is shown that the exposures are small compared to the standards. (auth)

23520 DATA. Radiol. Health Data Rep., 8: 5-64(Jan. 1967).

The ^{89}Sr, ^{90}Sr, ^{131}I, ^{137}Cs, and ^{140}Ba content of milk in North America and Pan America during Sept. 1966 is reported by the national and international milk surveillance networks, and the Oklahoma and Texas networks report the ^{40}K, ^{131}I, ^{90}Sr, and ^{137}Cs content of local milk samples. The intake of ^{89}Sr, ^{90}Sr, ^{137}Cs, and ^{226}Ra in institutional diets in the United States during April to June, 1966 is reported, as is the estimated daily intake of radioisotopes in California diets during Jan. to April 1966. Gross radioactivity levels in surface waters of the United States during July, 1966 are reported along with the total beta-radioactivity in the Minnesota water supplies during Jan. to June, 1966. Airborne particulate and precipitation radioactivity levels are given for North America and Pan America for July to Sept., 1966 in terms of gamma radioactivity in surface air. The ^{131}I content of bovine thyroids in the United States during Jan. to June 1966 is reported. The Atomic Energy Commission publishes the environmental levels of radioactivity at its Oak Ridge Area, Paducah, and Portsmouth sites during Jan. to June 1966 and announces three underground nuclear tests during Dec. 1966, and detection of the fifth Chinese nuclear test. (E.R.B.)

23521 ^{210}Po IN TOBACCO PRODUCTS AND HUMAN TISSUES. Ferri, E. S.; Baratta, E. J. (Public Health Service, Winchester, Mass.). Radiol. Health Data Rep., 7: 485-8(Sept. 1966).

Using a smoking machine, tobacco smoke was collected. It was found that the ^{210}Po content of the tobacco smoke accounted for 11 to 30 percent of that found in the total product, depending on the type of filter used. Analyses of human tissues indicated that the lung, blood, and liver, in that order, of smokers contained more ^{210}Po than the corresponding organs of nonsmokers. (auth)

23522 DATA. Radiol. Health Data Rep., 7: 493-548 (Sept. 1966).

Data are presented on the following surveillance activities; the ^{89}Sr, ^{90}Sr, ^{137}Cs, ^{131}I, and ^{140}Ba content of milk during May, 1966 in North America and Pan America according to national and international surveillance stations, the ^{40}P, ^{89}Sr, ^{90}Sr, ^{137}Cs, and ^{65}Zn content of milk during Jan. to March, 1965 is reported by the California, Oregon, and Washington Milk Networks, the ^{90}Sr content of human diet in New York City, San Francisco, and Chicago is reported for Nov., 1965 to Jan. 1966, the estimated daily intake of radioisotopes in California diets is presented Sept. to Dec., 1965, the gross alpha- and beta-radioactivity levels of surface waters in the United States is given for March, 1966, the gross beta-radioactivity levels in airborne particulates and precipitation in North America and Pan America during May 1966 is given along with the ^{90}Sr fallout in the United States during July to Dec., 1965, the ^{90}Sr content in human bone in the United States during April to June, 1965 and the environmental levels of radioactivity at Argonne National Laboratory, Atomic International, National Reactor Testing Station, and Oak Ridge are given. The ^{137}Cs and ^{90}Sr content of the environment in the Elk River, Minn., dairylands is presented, and finally the Atomic Energy Commission announces one underground nuclear test at its Nevada Test Site during August, 1966. (E.R.B.)

23523 CHARACTERISTICS OF DOSIMETERS FOR MEASURING INDIVIDUAL RADIATION DOSES. Luykx, F. F. (EURATOM, Brussels). J. Belge Radiol., 50: 325-35(1967). (In French).

The characteristics of the ideal individual dosimeter are given followed by a description of the filmdosimeter, thermoluminescent dosimeter, photoluminescent dosimeter and condenser-ionisation chamber. Their respective advantages and drawbacks are discussed. A table is given comparing the characteristics of the first three types of dosimeters. (auth)

23524 BASIC STANDARDS AND NEW CONCEPTS OF THE INTERNATIONAL RADIOLOGICAL PROTECTION COMMITTEE. Recht, P. (EURATOM, Brussels). J. Belge Radiol., 50: 318-24 (1967). (In French).

Recent publications by the International Radiological Protection Committee suggest some new concepts and a new terminology. The changes that they might bring about in the basic standards for maximum permissible doses are considered. (auth)

23525 PROTECTION OF WORKERS AGAINST INDUSTRIAL USE OF X RAYS. Halleux, O. (Usines Balteau, Liege). J. Belge Radiol., 50: 312-17(1967). (In French).

The industrial use of x rays led various countries to lay down a number of basic standards for the protection of their workers. The principles on which the Belgian basic standards NBN 491 is based are explained. The precautions to be taken when using x ray equipment in shielded-rooms and on building-yards are reviewed. (auth)

23526 MEASUREMENT OF INTERNAL RADIATION DOSE BY SPECTROMETRY. Colard, J. (CEN, Mol, Belg.). J. Belge Radiol., 50: 304-11(1967). (In French).

Sodium iodide scintillation and spectrometry are used in the total body counter of C.E.N. at Mol. Internal contamination is assessed with this apparatus by an interpretation of the measurements that takes into account not only the way in which the contamination occurred but also the metabolism of the radioactive element in the body. The author shows that, especially in the case of iodine and phosphorus isotopes, the use of the I.C.R.P. data may give quite different results from those obtained by considering the metabolic cycle. (auth)

23527 RISKS OF RADIOACTIVE INTERNAL CONTAMINATION OF WORKERS AND METHODS OF PREVENTION. Lafontaine, I. (CEN, Mol, Belg.). J. Belge Radiol., 50: 293-303 (1967). (In French).

Internal contamination hazards of workers in research laboratories and industrial installations are assessed; various ways in which contaminating materials enter the body, and the physiological behavior of some of these are discussed. The means, collective and individual, whereby contamination can be prevented, taking into consideration among other things, the demarcation of working areas, the disposal of gaseous effluents, the monitoring of working areas and workers' individual equipment are examined. (auth)

23528 INTRODUCTION TO THE PROBLEM OF CONTAMINATION IN RADIOPROTECTION. Boulenger, R. (CEN, Mol, Belg.). J. Belge Radiol., 50: 291-2(1967). (In French).

The role of health physics in measuring and reducing radiation doses is discussed and methods for measuring internal contamination are reviewed. (H.L.W.)

23529 SOME PROBLEMS AND METHODS OF DOSIMETRY IN RADIOBIOLOGICAL EXPERIMENTS. Grammatikati, V. S.; Sokolova, I. K. pp 34-52 of Voprosy Obshchei Radiobiologii. Domshlak, M. P. (ed.). Moscow, Atomizdat, 1966. (In Russian).

A survey of the literature on equipment and procedures for dosimetry in radiobiological experiments is presented. (JPRS)

23530 PHYSICAL ASPECTS OF THE RELATIVE BIOLOGICAL EFFECTIVENESS OF RADIATION. Avetisov, G. M.; Sokolova, I. K. pp 215-35 of Voprosy Obshchei Radiobiologii. Domshlak, M. P. (ed.). Moscow, Atomizdat, 1966. (In Russian).

A survey of the literature on the physical aspects of the relative biological effectiveness of radiation is presented. (JPRS)

23531 DOSE MEASUREMENTS WITH THE HELP OF AN IONIZATION CHAMBER AT AN X-RAY UNIT FOR PRODUCTION OF SMALL BEAMS. Truckenbrodt, Wilfried; Pychlau, Peter (Heiligenberg Inst., Ger. Physikalisch-Technische, Freiburg i. B.). Strahlentherapie, 134: 553-60(Dec. 1967). (In German).

An x ray unit for the production of micro-beams by means of lead diaphragms is discussed. The exposure is measured by means of an ionization chamber which is in certain openings beneath the object during irradiation. This monitor is calibrated against a second ionization chamber which determines the exposure at the place of the irradiated object. A large decrease in exposure rate is measured if this ionization chamber is not placed directly upon the upper edge of the distance cylinder but is placed some distance over air or glass. Using different illumination of the chamber volume according to the corresponding diameter of the diaphragm opening, it was shown that the exposure rate is independent of the diameter of the diaphragm opening. The effective beam is surrounded by a scattered radiation envelope. (auth)

23532 INVESTIGATION OF THE DOSE DISTRIBUTION IN DOMESTIC SWINE UNDER WHOLE-BODY X-IRRADIATION WITH THE HELP OF LITHIUM FLUORIDE THERMOLUMINESCENCE DOSIMETRY. Roesler, Bernward; Nicht, Manfred; Reichel, Gerhard (Strahleninstitut und der Strahlentherapeutische Klinik, Magdeburg, Ger.). Strahlentherapie, 134: 545-52(Dec. 1967). (In German).

Using lithium fluoride thermoluminescent dosemeters, the dose distribution occurring in domestic pigs (36 kg) during whole-body irradiation with conventional x rays was registered. The ratio maximum organ dose/minimum organ dose was 3.13, and the ratio entrance dose/exit dose was 4.34; therefore, this is an inhomogeneous irradiation according to the report of the ICRU. (auth)

23533 NEUTRON DOSIMETRY WITH THE HELP OF THE THERMOLUMINESCENCE OF LITHIUM FLUORIDE. Stolterfoht, Nikolaus; Jacobi, Wolfgang (Hahn-Meitner-Institut fuer Kernforschung, Berlin). Strahlentherapie, 134: 536-44 (Dec. 1967). (In German).

The response of ^{7}LiF-thermoluminescence dosimeters with different envelopes (teflon, polyethylene, alcohol) for fast neutrons in the energy range of 3 to 15 MeV was measured. The possibilities to determine the γ- and n-dose in mixed radiation fields by use of two LiF-dosimeters with equal γ-sensitivity but different n-sensitivity are pointed out. The LET-dependence of the thermoluminescence yield is discussed. (auth)

23534 ^{90}Sr DIETARY INTAKE ESTIMATES BASED ON FRACTIONAL INTAKES DUE TO MILK. Grundy, Richard D. (National Center of Radiological Health, Rockville, Md.). Radiol. Health Data Rep., 8: 73-7(Feb. 1967).

Data obtained through the pasteurized milk network on the ^{90}Sr content of milk that was consumed in selected sites throughout the United States, was used to estimate the total institutional dietary consumption of ^{90}Sr and Ca. Milk consumption in selected sites is tabulated, and equations for determining the percentage of milk in the total diet are presented. Strontium-90 and Ca contents are also calculated. (E.R.B.)

23535 SAFETY CONTROL METHODS IN THE USE OF SOURCES OF IONIZING RADIATION. Terman, A. V. Med. Radiol., No. 12, 43-4(Dec. 1966). (In Russian).

In evaluating the effectiveness of protective measures, one-time measurements of the dose rate should be used only to characterize the processes that are not related to changes in the radiation intensity during the entire time of the work (week, month, or longer). If there is a need to characterize the operations in terms of radiation intensity changing with time, the number of measurements should be sufficient to obtain a picture of the irradiation that is close to the actual one. These measurements should first be obtained by time studies of the operations. The series of measurements thus obtained should then be integrated to yield the characteristics of the dose rate throughout the work day or week. (JPRS)

23536 SOMATIC CHROMOSOMAL ABERRATIONS. USE IN THE EVALUATION OF HUMAN RADIATION EXPOSURES. Bender, Michael A. (Oak Ridge National Lab., Tenn.). Arch. Environ. Health, 16: 556-64(Apr. 1968).

Analysis of radioinduced chromosome aberrations in human leukocytes in short-term cultures for use in biological dosimetry of fission neutrons, γ, and x radiations is considered. The coefficients of aberrations produced in chromosomes of leukocytes in freshly-drawn human peripheral blood were determined following exposure to a wide variety of radiations. The validity of the coefficients derived in vitro was tested by comparison with the frequency of chromosome aberrations in leukocytes from persons exposed accidentally. Observed aberration yields agreed well with predicted yields. It is pointed out that analysis of chromosome aberration analysis does not provide a means of radiation dosimetry for all types and all cases of radiation exposure, but that it does provide a useful means of estimating radiation dose providing the many factors that modify aberration yields are considered. Techniques previously used included a check on film badge readings in cases where the film badge was blackened. (C.H.)

23537 QUALITATIVE CHANGES IN LYMPHOCYTES AS INDEX OF EXPOSURE TO IONIZING RADIATION. Schneiberg, K.; Kwasniewska, C.; Czaplewski, S. Pol. Med. J., 6: 1154-62 (1967).

Translated from Pol. Tyg. Lek., 21: No. 52, (1966).

The value of five selected indexes used in the diagnosis of im-

minent or actual injury caused by x radiation was estimated in patients, in healthy persons, and in an experimental study in mice. The indexes are based on the qualitative evaluation of lymphocytes of the peripheral blood. They consist in the determination of the percentage of lymphocytes containing nuclear satellites, percentage of bi- and polysegmented forms, of the ratio of large to small lymphocytes, of the ratio of large lymphocytes + monocytes to small lymphocytes, and of the ratio of granular to agranular lymphocytes. Although none of these indexes is specific, and some of them are of low sensitivity, it was concluded that these indexes may be helpful in revealing imminent and early radiation injury. Characteristic deviations were observed under the effect of radiation. The tests are easy in performance and interpretation. (auth)

23538 GAMMA-RAY DOSIMETRY OF INTERNAL EMITTERS. III. ABSORBED FRACTIONS FOR LOW ENERGY GAMMA RAYS. Reddy, A. R.; Ellett, W. H.; Brownell, G. L. (Massachusetts General Hospital, Boston). Brit. J. Radiol., 40: 512-15(July 1967).

Results of exact multiple scattering calculations carried out by means of the Monte Carlo method are presented for γ ray energies ranging from 20 to 100 keV. These results are formulated in terms of absorbed fraction, the fraction of the emitted γ energy absorbed in a unit density tissue phantom of specified mass and shape. For central source and uniform source configurations, absorbed fractions for total-body phantoms ranging in mass from 10 to 100 kg are given, as are results, applicable to cases of a uniform distribution of activity in organs of various shapes ranging in mass from 0.3 to 6 kg. (auth)

23539 AUTORADIOGRAPHIC ANALYSIS OF PLUTONIUM CONTAMINATION ON PIG SKIN. I. Tashiro, Shingo (Japan Atomic Energy Research Inst., Tokyo). Hoken Butsuri, 2: 128-33(Sept. 1967). (In Japanese).

Autoradiographic analysis was used to carry out experiments on plutonium contamination of pig skin. It was found that plutonium contaminated hair tops, hair shafts, hair follicles, furrows, and pores on the skin. Hair contamination could not be disregarded in the decontaminating treatment. Exact analysis of skin contamination by plutonium needed further investigation. (NSA of Japan)

23540 CHANGES OF CONCENTRATION OF ^{90}Sr AND ^{137}Cs IN RAW MILK COLLECTED AT DAIRY FACTORIES IN TOHOKU DISTRICT. Nakanishi, Takeo; Sugawara, Hiroshi (Tohoku Univ., Japan). Rakuno Kagaku No Kenkyu, 16: No. 3, A85-7(June 1967). (In Japanese).

The ^{90}Sr and ^{137}Cs content of raw milk collected at some representative dairies in the Tohoku District of Japan were measured in the summer (June and August, 1966) and winter (December 1966 and February, 1967). The average contents of ^{90}Sr and ^{137}Cs in milk were 18.6 and 46.6 pCi/l milk in summer and 10.9 and 20.3 pCi/l milk in winter respectively. Strontium-90 and ^{137}Cs contents of milk had a tendency to decrease in 1966 when compared with those of 1964. There was a remarkable ^{137}Cs decrease in content. No influence of the nuclear tests in China during 1966 was observed on contents of ^{90}Sr and ^{137}Cs in milk. (NSA of Japan)

23541 SURFACE CONTAMINATION. Proceedings of a Symposium held at Gatlinburg, Tennessee, June 1964. Fish, B. R. (ed.). New York, Pergamon Press, 1967. 423p. $21.50. (CONF-555).

Separate abstracts were prepared for 17 reports on various aspects of surface contamination. Abstracts of remaining papers of the conference appeared in NSA as: 18: 29880, 31786, 31791; 31800; and 19: 4394, 5920, 6062, 6123, 7760, 9428, 9430, 9759, 13696, 20191, 22164, 24747. (H.L.W.)

For abstracts of individual papers see: 23542–23558.

23542 ADHESION OF RADIOACTIVE GLASS PARTICLES TO SOLID SURFACES. Walker, R. L.; Fish, B. R. (Oak Ridge National Lab., Tenn.). pp 61-2 of Surface Contamination. Fish, B. R. (ed.). New York, Pergamon Press, 1967.

From International Symposium on Surface Contamination, Gatlinburg, Tenn., June 1964. See CONF-555.

Factors affecting the adhesion of particles to plane surfaces are discussed. A method for removing neutron-activated glass beads from a quartz surface by subjecting the surface to sonic vibrations is described. The system is capable of producing a maximum g force equivalent to 2.8×10^{-6} dyne for 28.9 μ diameter particles of density 2.5. (H.L.W.)

23543 THE CONCEPT OF DERIVED WORKING LIMITS FOR SURFACE CONTAMINATION. Dunster, H. J. (United Kingdom Atomic Energy Authority, Harwell, Eng.). pp 139-47 of Surface Contamination. Fish, B. R. (ed.). New York, Pergamon Press, 1967.

From International Symposium on Surface Contamination, Gatlinburg, Tenn., June 1964. See CONF-555.

The following aspects of derived working limits for contamination of the workers' environment are discussed: inhalation in controlled areas, external radiation in controlled areas, permissible values for general areas, area over which surface contamination may be averaged, and recommended values. The following aspects of drrived working limits for contamination of skin are discussed: calculation of derived working limits, external radiation from skin contamination, ingestion of radioactivity from skin contamination, inhalation of radioactivity from skin contamination, penetration of the skin, recommended limits, and action following excessive contamination of skin. A simplified model for calculating the alpha radiation dose to the basal layer of the epidermis from radioactive material partially penetrating the skin is presented. (H.L.W.)

23544 PERMISSIBLE CONTAMINATION LIMITS. Spangler, G. W. (Univ. of California, Los Angeles); Willis, C. A. pp 151-8 of Surface Contamination. Fish, B. R. (ed.). New York, Pergamon Press, 1967.

From International Symposium on Surface Contamination, Gatlinburg, Tenn., June 1964. See CONF-555.

The establishment of permissible contamination limits (PCL), presents a practical approach to control of radioactive contamination hazards. External dose rate determinations are given for gamma, beta, and alpha contaminants. Internal dose determinations are given for inhaled radioactive materials, since this is the primary route of entry into the body from contaminated surfaces. Cutaneous absorption is not considered an important hazard, and the ingestion hazard is negligible for personnel working with contaminated surfaces. It was concluded that surface contamination hazards are not completely controlled by the established maximum permissible dose and maximum permissible concentrations; values for PCL based on a conservative assessment of potential inhalation and direct radiation hazard are sufficient to protect other surface contamination hazards; and current data appear insufficient for the establishment of specific PCL values for each individual isotope. (H.L.W.)

23545 THE ESTABLISHMENT OF LIMITS FOR RADIOACTIVE SURFACE CONTAMINATION. Blatz, Hanson (New York Univ., New York City Office of Radiation Control); Eisenbud, Merril. pp 163-7 of Surface Contamination. Fish, B. R. (ed.). New York, Pergamon Press, 1967.

From International Symposium on Surface Contamination, Gatlinburg, Tenn., June 1964. See CONF-555.

A survey of the exposure of workers in the radium dial painting industry in and around New York City was conducted. The total radium body burden was measured by analysis of expired breath for radon. Relations between airborne concentrations, work surface and floor contamination, and body burden were studied. Results indicated that no reliable relation between surface contamination and health hazards could be established. Work surface contamination limits used in foreign countries were compared with results of this study. Legal considerations of health hazards from surface contamination are pointed out. (H.L.W.)

23546 STUDIES OF THE SIGNIFICANCE OF SURFACE CONTAMINATION. Glauberman, H.; Bootmann, W. R.; Breslin, A. J. (Atomic Energy Commission, New York). pp 169-78 of Surface Contamination. Fish, B. R. (ed.). New York, Pergamon Press, 1967.

From International Symposium on Surface Contamination, Gatlinburg, Tenn., June 1964. See CONF-555.

Differences in the relation between air-dust concentration and removable surface contamination were observed at two facilities of the Health and Safety Laboratory. No correlation was found between results of specific experiments and surface and air contamination measurements performed during normal operations in uranium and beryllium facilities. The data indicated that air-surface contamination relations derived at one facility were not valid at another facility except by coincidence. In the case of the uranium facilities and the beryllium facility that were included in the study, limits of surface contamination appeared to be meaningless because sources of contamination other than surface contamination are predominant in terms of concentration in air. For materials of greater specific activity than uranium, such as plutonium, surface contamination could be the source of excessive dust concentration in air. (H.L.W.)

23547 A METHOD FOR EVALUATING SURFACE CONTAMINATION OF SOFT BETA EMITTERS. Prince, John R.; Wang, Chih H. (Oregon State Univ., Corvallis). Contract AT(45-1)-

1387. pp 179-83 of Surface Contamination. Fish, B. R. (ed.). New York, Pergamon Press, 1967.

From International Symposium on Surface Contamination, Gatlinburg, Tenn., June 1964. See CONF-555.

The technique of liquid scintillation counting was applied to evaluation of swipes from surfaces contaminated with soft beta emitters. The counting efficiency of a number of compounds containing ^{14}C or ^{3}H was determined. Results are presented in tabular form. In view of the simplicity of the method and its suitability for rapid evaluation of large numbers of samples, it can be recommended for a variety of applications. Among the factors to be considered in the analysis of data are the counting efficiency, the composition of the counting solution and the solubility of the radiocontaminant in the counting solution, and the parameters such as surface porosity, that influence the swipe test. (H.L.W.)

23548 PERFORMANCE OF SURFACE CONTAMINATION DETECTORS FOR ONTARIO HYDRO MAXIMUM PERMISSIBLE LEVELS OF SURFACE CONTAMINATION. Wilson, R.; Vivian, G. A. (Ontario Hydro, Toronto). pp 197-200 of Surface Contamination. Fish, B. R. (ed.). New York, Pergamon Press, 1967.

From International Symposium on Surface Contamination, Gatlinburg, Tenn., June 1964. See CONF-555.

Techniques used to evaluate the performance of surface contamination detectors in use at the Nuclear Power Demonstration Reactor and the response of these instruments for maximum permissible levels of surface contamination are described. Uniformly contaminated circular surfaces of area from 10 cm^2 to 300 cm^2 were constructed by depositing aliquots of $^{90}Sr-^{90}Y$ solution on a gird. The response of various detectors to the contaminated plaques is presented in tabular form. (H.L.W.)

23549 TECHNIQUES FOR ASSESSING REMOVABLE SURFACE CONTAMINATION. Royster, George W. Jr.; Fish, Birney R. (Oak Ridge National Lab., Tenn.). pp 201-7 of Surface Contamination. Fish, B. R. (ed.). New York, Pergamon Press, 1967.

From International Symposium on Surface Contamination, Gatlinburg, Tenn., June 1964. See CONF-555.

Measurements of surface contamination by smear and adhesive paper techniques are evaluated and a third procedure is described. This new technique employs air impingement to redisperse loose contamination from the surface. The resulting airborne material is then collected on a filter and analyzed. Surface characteristics affecting the measurement and redispersion of particulates are discussed. The effect of particle size on the measurement and redispersion of particulates is presented in graph form. (H.L.W.)

23550 PREPARATION OF STANDARDIZED TEST DUSTS. Kerringan, W. J. (Savannah River Lab., Aiken, S. C.). Contract AT(07-2)-1. pp 219-26 of Surface Contamination. Fish, B. R. (ed.). New York, Pergamon Press, 1967.

From International Symposium on Surface Contamination, Gatlinburg, Tenn., June 1964. See CONF-555.

An air elutriation process is described that yields reproducible dusts of natural uranium oxide with a frequency distribution of more than 0.2 μ but less than 44.0 μ. Preliminary results with aluminum powder show that frequency distributions of 0.2 μ to 44.0 μ are attainable. The aluminum powders, although in the desired range, are not classified as well as uranium oxide. It was demonstrated that two month storage of uranium oxide dust in a sealed vial did not produce any serious agglomeration. (H.L.W.)

23551 SOME NEW DEVICES USED IN PLUTONIUM CONTAMINATION CONTROL. Putzier, E. A. (Dow Chemical Co., Golden, Col.). Contract AT(29-1)-1106. pp 229-34 of Surface Contamination. Fish, B. R. (ed.). New York, Pergamon Press, 1967.

From International Symposium on Surface Contamination, Gatlinburg, Tenn., June 1964. See CONF-555.

The alpha flasher is a device for detecting glove failures in glove box operations. The instrument is a transistorized air proportional counter that was used for more than two years with reputable efficiency. A downdraft glove change hood was developed for contamination and ventilation control during a glove change. The operation of the apparatus is based on the flow of air down and over the face of the glove part toward the bottom of the hood where it is evacuated. The development of the glove change ring has brought the glove changing operation to the point of absolute contamination control. All of these devices are illustrated and described in detail. (H.L.W.)

23552 ESTIMATION OF THE DOSE RATE OF FALLOUT DEPOSITION BY X-RAY SPECTROMETRY. Franke, Th. (Max Planck-Institut fuer Biophysik, Frankfurt, am Main). pp 257-60 of Surface Contamination. Fish, B. R. (ed.). New York, Pergamon Press, 1967.

From International Symposium on Surface Contamination, Gatlinburg, Tenn., June 1964. See CONF-555.

A vehicle for mobile x ray spectrometry measurements of fallout deposition was constructed. Instruments in the vehicle are described and methods for calibration and operation are explained. It is possible to accurately calculate very small dose rates. The method is also applicable to the control of dose rates in the area surrounding reactors, laboratories working with radioisotopes, as well as for detecting the hazards to the population from gamma-emitting radioisotopes deposited on the ground. (H.L.W.)

23553 PLUTONIUM MONITORING TECHNIQUES FOR ZPR-III. Graham, E. D.; Stoddart, P. G.; Severn, F. W. (Argonne National Lab., Idaho Falls, Idaho). pp 293-8 of Surface Contamination. Fish, B. R. (ed.). New York, Pergamon Press, 1967.

From International Symposium on Surface Contamination, Gatlinburg, Tenn., June 1964. See CONF-555.

Potential hazards of plutonium loading of Zero Power Reactor III are described. Extensive control and safety procedures are applied in the loading of plutonium and permissible contamination levels are essentially zero. The following aspects of plutonium health physics are discussed: inspection, counting and handling procedures; personnel protection measures; air monitoring; and isotopic identification of contaminants. (H.L.W.)

23554 PRACTICAL ASPECTS OF SURFACE CONTAMINATION CONTROL AT A.W.R.E. Saxby, W. N.; Hole, J. A. pp 299-307 of Surface Contamination. Fish, B. R. (ed.). New York, Pergamon Press, 1967.

From International Symposium on Surface Contamination, Gatlinburg, Tenn., June 1964. See CONF-555.

Measures for reducing the possibility of widespread contaminants were established at the Atomic Weapons Research Establishment in order to prevent dispersion of radioactive materials and beryllium. Within the Weapons Group of the UKAEA the responsibility for providing advice on radiological and beryllium safety and for providing ancillary services was placed in the Health Physics Branch of the Group Safety Division. Derived working limits for surface contamination with alpha and beta emitters are given and monitors for measuring contamination are described. In twelve years of operating experience no significant surface contamination problems in working areas for either radioactive materials or beryllium have developed. (H.L.W.)

23555 ENVIRONMENTAL RADIOACTIVITY AND BODY BURDEN. Burton, L. K.; Cole, J. S. (Berkeley Nuclear Lab. Eng.). pp 309-16 of Surface Contamination. Fish, B. R. (ed.). New York, Pergamon Press, 1967.

From International Symposium on Surface Contamination, Gatlinburg, Tenn., June 1964. See CONF-555.

Current investigations on the development of instruments to provide a rapid measure of contamination from specific nuclides and the internal dose to the individual from given contamination levels are described. Hazards to the worker are determined by monitoring either the air breathed by the worker, or the body burden. A biological monitoring program is being developed to obtain the following data: air and surface contamination values from conventional techniques, air activity from personal air samplers, urine and fecal activities, body burdens, and excretion rates. Information from these data is used to determine the relation of the present working limits of contamination to the hazard to the individual. (H.L.W.)

23556 ECONOMICS OF SURFACE CONTAMINATION AS RELATED TO INSURANCE. McAllister, R. G. (Liberty Mutual Insurance Co., Hopkinton, Mass.). pp 353-7 of Surface Contamination. Fish, B. R. (ed.). New York, Pergamon Press, 1967.

From International Symposium on Surface Contamination, Gatlinburg, Tenn., June 1964. See CONF-555.

The Nuclear Liability Pools were formed as a result of the potential magnitude of a major nuclear incident. Since the high limits requested by the reactor operators were beyond the financial capabilities of any one company, two Liability Pools were organized. The Stock Pool, the Nuclear Energy Liability Insurance Association, has a capacity of \$46½ million for any one risk and the Mutual Pool, Mutual Atomic Energy Liability Underwriters, a capacity of \$13½ million for any one risk. To provide still greater protection, the Price–Anderson Amendment to the Atomic Energy Act was enacted. The Limited Form Exclusion Endorsement is used with private passenger type automobile liability policies and the comprehensive personal liability coverages. The Broad Form Exclusion is used with commercial type automobile and general liability policies. The insurance industry, the Congress, and the Atomic Energy Commission have constructed a framework capable

of dealing with problems created by atomic energy, even though the hazard is unpredictable. (H.L.W.)

23557 APPLICATIONS OF MODERN TECHNIQUES OF DECONTAMINATION AT THE SACLAY CENTER OF NUCLEAR STUDIES. Cerre, P.; Mestre, E. (Commissariat a l'Energie Atomique, Saclay, France). pp 369-76 of Surface Contamination. Fish, B. R. (ed.). New York, Pergamon Press, 1967. (In French).

From International Symposium on Surface Contamination, Gatlinburg, Tenn., June 1964. See CONF-555.

The investigation of new methods for the decontamination of surfaces to supplement the current techniques of washing, soaking, grinding, and granulation is discussed. Two methods of decontaminating materials are described: decontamination of lead and electrolytic polishing. Decontamination of lead is accomplished by chemical methods using acetic acid and hydrogen peroxide, or by fusion of lead with antimony. Techniques of electrolytic polishing for decontamination are described. (H.L.W.)

23558 REMOVAL OF THE RADIOACTIVE SURFACE CONTAMINATIONS. Nishiwaki, Yasushi; Nishioka, Hajime (Tokyo Inst. of Tech.). pp 377-89 of Surface Contamination. Fish, B. R. (ed.). New York, Pergamon Press, 1967.

From International Symposium on Surface Contamination, Gatlinburg, Tenn., June 1964. See CONF-555.

The following levels of contamination are defined: free contamination, the contamination that can be easily removed by air or vacuum, by applying the water or smear test, loose contamination, the contamination that can not be removed without applying decontamination agents; and fixed contamination, the contamination that can not be removed without affecting removal of some portions of the contaminated surface. The three levels of contamination were measured using ^{89}Sr, ^{131}I, and fission products deposition on the smooth nonporous surface of glass and the rough porous surface of cotton textile. The decontamination patterns, as expressed by the relation between the decontaminated per cent and the period between the time of contamination and the time of decontamination resemble each other, although the decontaminated per cent was observed to differ considerably between the porous cotton textile and the non-porous glass surface. In the case of foliage surfaces, a different decontamination pattern was observed. In the case of foliage surface contamination, the difference in the decontaminated per cent between decontamination by water and by the combined use of chelating agent EDTA-2Na and surfactant DBS(Dodecyl benzene sulfonate) was observed to increase with the period between the time of contamination and that of decontamination. (H.L.W.)

23559 VORSICHT, RADIOAKTIVE LEUCHTFARBEN. (Caution, Radioactive Luminous Paint). Merkblatt 1013/1967. Lucerne, Switzerland, Swiss National Accident Insurance Inst., 1967. 4p.

Radioactive luminous paints as applied to the dials and hands of watches and meters, etc., are fraught with hazards for the health of the persons responsible for preparing the pigments and paint. Their safe use is possible, however, provided correct working procedures and the rules relating to the handling of radioactive luminous paint are scrupulously observed (precautions required in storing, unpacking and preparation to be done only in vacuum chamber [glove box], strict hygienic practices, etc.). General advice on safe working procedures in isotope laboratories is also included. (Occup. Safety and Health Abstr.)

Medicine

Refer also to abstracts 23285, 23398, 23416–23418, 23466, 23472, 23482, 23599, 23639, 23646, 23661, 23662, 23673, and 23690.

23560 X RAY TREATMENT OF LYMPHOSARCOMA AND SARCOMA RETICULARIS: ANALYSIS OF 100 CASES. Chang, Nai-sheng. Chung Hua Pi Fu Ko Tsa Chih, 9: No. 2, 98(Apr. 1963). (In Chinese).

Fifty-six cases of lymphatic and 44 cases of reticular cell sarcoma were treated by x radiation between 1952 and 1958. Methods of irradiation included wide-field large dose, local supplementary irradiation, and irradiation of the lymph system along uninfected areas. There was no local recurrence following the use of these methods. After five years the subsistence rate was found to be 10.4%. Factors affecting efficacy and complications are discussed. (JPRS)

23561 ULTRAVIOLET AND INFRARED RADIATION SOURCES CHIRANA. Pavlinec, M.; Chirana, Stara Tura. Jemna Mech. Opt., 12: 236-7(Aug. 1967). (In Czech).

Medical benefits derived from uv radiation at 240 to 320 nm with an optimum at 280 nm, and ir radiation with wavelengths of 760 to 1500 nm are discussed. Chirana enterprises produce the radiation source SANUS for uv waves with a mercury high pressure tube RVK 250 with wavelengths of 297 and 253 nm. The SANUS unit can also work with an ir source using two ceramic tubes using a current intensity of 4.9 A. The uv tube takes 2.8 A. Another combined unit is the portable MIKROLUX using 2.5 A and operating in the uv range with the tube RVK 125. The large unit JAVORINA is also designed for both the uv and ir radiation using 900 VA and designed for hospitals and ambulatory surgeries. It may be used for space sterilization. (JPRS)

23562 X RAY DEPILATION TREATMENT OF 379 CASES OF FUNGUS DISEASES. Che, Nai-tseng; Pai, Jui-ming; Cheng, Fo-chou. Chung Hua Pi Fu Ko Tsa Chih, 9: No. 2, 107-8(Apr. 1963). (In Chinese).

Results of treatment of 379 cases of fungus diseases of the head during the past five years using x-ray depilation are reviewed. A study was made on technique, dosage, and reactions to the x-ray radiation used. Follow-ups in 102 cases showed recurrence in five cases after half a year and in one case after one year, giving a total recurrence rate of 5.8%. (JPRS)

23563 THERAPY WITH OPEN RADIONUCLIDES. Hoffmann, G. (Medizinische Univ., Freiburg i. B.). Kerntechnik, 10: 102-7(Feb. 1968). (In English and German).

The use of orally or parenterally administered radioisotopes for the treatment of various disease conditions is discussed. It is pointed out that the metabolic pathways used for the preferential localization of radioisotopes in the desired organ or focus of disease are similar to those used for radiodiagnosis, but the quantities of radioisotopes used are substantially larger in order to obtain a therapeutically effective radiation dose. Results are reviewed from applications of internally deposited radioisotopes for the treatment of various blood disorders, thyroid disorders, and neoplasms. These include the use of ^{131}I, ^{32}P, and ^{198}Au for the irradiation of lymph nodes in the treatment of leukemia and neoplastic systemic disorders such as Hodgkins disease; the use of ^{131}I for the selective irradiation of the thyroid gland for the treatment of hyperthyroidism, toxic adenoma, euthyroid goiter, and iodine-retaining malignant thyroid neoplasms; the use of ^{198}Au colloids for the treatment of chronic myeloid leukemias; the use of ^{32}P for the treatment of polycythemia vera; and the use of x-ray contrast media containing ^{131}I for the treatment of systemic disorders of the lymphatic system, such as lymphatic leukemia, Hodgkin's disease, and lymph node metastases of malignant neoplasms. (C.H.)

23564 RADIOSENSITIVITY OF DNA IN AQUEOUS SOLUTION. Shal'nov, M. I.; Krushinskaya, N. P. Izv. Sib. Otd. Akad. Nauk SSSR, Ser. Biol.-Med. Nauk, No. 5, 109-17(Apr. 1967). (In Russian).

On the basis of the criteria of the G values, a comparative study was made of the radiosensitivity of different links of DNA during its irradiation in free form, in DNP, and in cell nuclei. The degree of responsibility of this or of some primary reactions for the functional damage of the DNA was evaluated. (tr-auth)

23565 PHYSICAL AND CLINICAL CONSIDERATIONS OF THE BETATRON AFTER TWO YEARS OF USE. Leroux, G. F.; Chevalier, Ph.; Garsou, J.; Minet, P. (Univ., Liege). J. Belge Radiol., 50: 258-72(1967). (In French).

The Asclepitron Brown Boveri betatron was chosen in order to have a source of corpuscular electronic radiation in addition to electromagnetic radiation of the x-ray type. The reactions to the electrons and photons are mild and of less intensity than those observed with conventional irradiation. The use of electron therapy produced excellent results in the majority of lesions. The treatment of oro-pharyngeal cancer was enhanced by the use of electrons combined with curietherapy or with chemical therapy. (H.L.W.)

23566 PULMONARY VASCULAR SCINTIGRAPHY. Van Vaerenbergh, P. M.; Schelstraete, K. (Univ. of Ghent). J. Belge Radiol., 50: 273-87(1967). (In French).

Ten to fifty μ size macroaggregates of albumin labeled with ^{131}I or ^{99m}Tc are trapped in the lung capillaries after intravenous injection. Their distribution within the lung corresponds to the regional blood flow supplied by the pulmonary artery. When a lung-scan is performed poorly irrigated territories appear as cold areas. This technique was used first for the diagnosis of massive pulmonary embolism. Afterwards, impaired local circulation was also shown to exist in several other lung diseases. Lung scans were performed in 108 patients. Extensive reduction of regional pulmonary blood flow was demonstrated in bronchial carcinoma. The alterations are less severe in lung metastases. Local impairment of lung circulation was also found in cases of mediastinal tumors, pleural effusions, pleural thickening, old

tuberculosis, emphysema, chronic bronchial disease. In the future the functional aspect of this technique will be stressed, because it provides a visual representation of the pulmonary blood distribution under various conditions. (auth)

23567 KINETICS OF RESTORATIVE PROCESSES IN MAMMALS SUBJECTED TO γ IRRADIATION. Kovalev, V. P.; Eidus, L. Kh.; Plotnikova, E. D. Dokl. Akad. Nauk SSSR, 177: 1469-71 (Dec. 21, 1967). (In Russian).

Fractioned radiation methods were used to determine the influence of the kinetics of restorative processes on the mechanisms of chemical protection following whole-body irradiation of mammals by sub-lethal and non-lethal doses. Studies were carried out with 6500 CBA × C_{57} BL mice weighing 20 to 28 g and irradiated by ^{137}Cs γ rays with a dose rate of 450 R/min. Single and fractionated doses were used with intervals of two to fourteen days. Chemical radiation protector was provided by AET(aminoethylisothiouronium) at a dose of 65 mg per kg weight injected 10 to 15 min before exposure. The restoration curves constructed on the basis of the experiments indicated that the kinetics of restoration with the protective treatment and without it were identical. (R.V.J.)

23568 LEUKEMIA IN OFFSPRING OF ATOMIC BOMB SURVIVORS. Hoshino, Takashi; Kato, Hiroo; Finch, Stuart C.; Hrubec, Zdenek. Blood, 30: 719-30(Dec. 1967).

In a survey with 90 percent chance of detecting a quadrupling of risk, no significant increase in leukemia was observed in the offspring of persons exposed to atomic bomb radiation in Hiroshima and Nagasaki. In the children with leukemia who were born to previously irradiated parents, there was no unusual finding in regard to the interval from parental exposure to onset, age at onset, or type of leukemia. Failure to demonstrate a radiation effect does not mean that there is no such effect. It merely means that within the experience thus far open to observation, no effect is to be seen. There now is sufficient experience to justify a long period of observation of the F_1 and subsequent generations for a possible increase of leukemia. (auth)

23569 PROTECTION OF CANINE PANCREATIC ULTRASTRUCTURE AGAINST RADIATION BY PRETREATMENT WITH ALLOXAN. Volk, Bruno W.; Wellmann, Klaus F.; Lazarus, Sydney S. (Jewish Chronic Disease Hospital, Brooklyn). Amer. J. Pathol., 51: 207-24(Aug. 1967).

The radioprotective effects of an intravenous nondiabetogenic dose (15 mg/kg) of alloxan monohydrate on the fine structure of the exocrine pancreas and the islets of langerhans were investigated in dogs. One group (10 dogs) received 7000 to 9000 R x irradiation of the pancreatic remnant 15 min after partial pancreatectomy but not drug pretreatment. A second group (29 dogs) received alloxan 1 hr to 6 days prior to partial pancreatectomy followed in 15 min by 7000 to 9000 R to the remnant. A third group (6 dogs) received alloxan prior to partial pancreatectomy but irradiation was omitted. The alloxan-pretreated dogs exhibited a marked reduction in pancreatic amylase, leucine aminopeptidase, and lipase activities, whether or not they were irradiated. However, they did not suffer extensive ultrastructural alterations following irradiation as did the dogs who did not receive drug pretreatment. No abnormal islet changes, glucose tolerance curves or blood sugar values were observed as compared with normal controls (3 days). (M.M.B)

23570 A NEW PHOTOSENSITIZER: THE ARTIFICIAL SWEETENER CYCLAMATE. Lamberg, Stanford I. (Philadelphia General Hospital). J. Amer. Med. Ass., 201: 747-50(Sept. 4, 1967).

Ultraviolet-induced sensitivity to cyclamate was demonstrated in human subjects by skin testing. Exposure to uv radiation in the range 295 to 425 nm after ingestion of cyclamate caused perceptible erythema that occurred after a 30-sec exposure. At this site, and others receiving longer exposures, a distinct induration appeared within 24 hr and lasted for about one week. Within 48 hr, minute papules appeared over the indurated areas; these papules also lasted for about a week and during that week the exposed spots appeared eczematous. The erythema seen at 24 hr was slowly replaced (during the week) by a brownish pigmentation that faded gradually but that could still be seen at the 60-sec site one month after exposure. Abnormal photopatch tests were also noted when cyclamate was dissolved in petrolatum at a concentration of 5% and applied to the forearm under an adhesive patch for 24 hr; the forearm was then exposed to uv light. Effects of exposure of the subject to the test light before and after oral ingestion of cyclamate was also determined. Photosensitization is discussed in terms of drugs or compounds that produce phototoxicity and those that produce photoallergy. Photoallergy was considered to be the probable mechanism of photosensitivity to cyclamate. (BBB) (TSS)

23571 TRAUMATIC SPINAL ARACHNITIS AND THE GAMMA MYELOGRAPHY. Takacs, Piroska. Orv. Hetil., 108: 1228-9 (June 25, 1967). (In Hungarian).

In connection with a case of spinal arachnitis of traumatic origin, attention is called to the importance and usefulness of a new, safe examination method, gamma myelography, for the diagnosis of this disease and for the control of the therapeutic success. (JPRS)

23572 STIMULATION OF MITOSIS IN BONE MARROW AND THYMUS OF NORMAL AND IRRADIATED RATS BY DIVALENT CATIONS AND PARATHYROID EXTRACT. Perris, A. D. (National Research Council, Ottawa); Whitfield, J. F.; Rixon, R. H. Radiat. Res., 32: 550-63(1967).

Intraperitoneal injections of calcium and magnesium chlorides stimulated the entry of cells into mitosis in both bone marrow and thymus tissue of normal and irradiated rats, and thus reduced the mitotic delay induced by radiation exposure. Strontium and sodium chlorides were without effect. The stimulatory effect of calcium was evident in bone marrow even after 1000 R of whole-body irradiation. A subcutaneous injection of parathyroid extract was similar to calcium in stimulating mitosis in the bone marrow of irradiated rats, but the extract had no effect on mitosis in the thymus gland. (auth)

23573 PRECAUTIONS REQUIRED IN HANDLING RADIATION SOURCES IN MEDICINE. Muszynski, G. Tech. Ueberwach., 7: 380-7(Nov. 1966). (In German).

The need for such precautions is most evident in the case of operations which are not amenable to remote control or automation, such as in radium therapy, the care of radioactive patients and radiological diagnosis. If technically sound radiation protection equipment and procedures are used, and directives concerning distance from sources, time of exposure to radioactive fields and shielding are scrupulously followed, hazards to occupationally exposed personnel and to the general environment can be eliminated. (Occup. Safety and Health Abstr.)

23574 TRANSPLANTATION OF FRESH AND PRESERVED AUTOLOGOUS BONE MARROW TO DOGS IRRADIATED WITH A DOSE EXCEEDING THE LETHAL. Novikova, M. N.; Fedotenkov, A. G.; Chertkov, I. L. (Central Inst. of Hematology and Blood Transfusion, Moscow). Probl. Gematol. Pereliv. Krovi, 13: No. 2, 16-21(Feb. 1968). (In Russian).

Transplantation of freshly prepared and ultra low temperature preserved autologous bone marrow saved 12 of 14 dogs subjected to general x irradiation of doses of 1,000 to 1,200 R. Restoration of hemopoiesis began 1 to 2 weeks after the transplantation, and hemopoiesis indices attained subnormal figures within 1 to 2 months. Lymphopoiesis was not restored for prolonged periods. The problem of the optimal amount of bone marrow cells administered on various rates of hemopoiesis following administration of freshly prepared bone marrow in comparison with preserved bone marrow is discussed. (auth)

23575 FIRST EXPERIENCES OF CLINICAL UTILIZATION OF A BETATRON OF 42 MeV. Rovera, S.; Maestro, A.; Jucker, C.; Coucourde, F.; Cacciamali, I. (Univ., Pavia, Italy). Radiol. Med., 53: 1011-29(Oct. 1967). (In Italian).

The main technical characteristics of the Siemens Betatron of 42 MeV, installed by the Center of High Energy of the Istituto di Radiologia of the University of Pavia are described. Results of preliminary physico-dosimetric studies are also given. The clinical utilization of the Betatron began in August 1965; during the first 16 months of use, 414 patients suffering from malignant tumors were treated. The neoplastic forms selected for irradiation with photonic and electronic beams, the techniques of radiation preferably used in the treatment of the different tumoral localizations and also the principal observations drawn from the experience of the first period of activity are reported. (auth)

23576 PROTECTIVE EFFECT OF CYSTEAMINE AGAINST CORTICOSTEROID INCREASE AFTER X IRRADIATION. Flemming, K.; Geierhaas, B. (Univ., Freiburg i. B. Heiligenberg Inst., Ger.). Naturwissenschaften, 54: 493-4(Jan. 1967). (In German).

To determine the protective effects of cysteamine against corticosteroid increase, male rats were exposed to a whole body irradiation of 1,000 R. Five minutes before irradiation they received an intraperitoneal injection of cysteamine. After decapitation, the corticosteroid determination was made in the adrenal and peripheral blood. The results show that cysteamine inhibited the increase of the adrenal cortex activity. It also had a specific radiation effect. When the hyperactivity of the adrenal cortex is damaged in irradiated animals and the radiosensitivity is increased, the cysteamine effect described represents a biological

partial component of its radioprotective effect to the whole animal. (J.S.R.)

23577 PATHOLOGICAL CONSIDERATION ON THE EFFECT OF RADIOACTIVE COBALT IRRADIATION ON LARYNGEAL CANCER. Maruoka, Shuzo (Tokyo Women's Medical Coll.). Tokyo Joshi Ika Daigaku Zasshi, 37: 304-19(May 1967). (In Japanese).

Nine cases of extirpated larynx after cobalt irradiation were investigated; clinical reports together with histopathological studies were made. The main effect of γ-irradiation was degeneration and destruction of tumor cells and induced tumor cell infiltration into the collagenous stroma. Histological comparison of the tissues before and after irradiation revealed degeneration of the stroma and proliferation of the interwoven tumor cells; a new relation of the parenchyme and stroma of the tumor was produced after irradiation. Tumor cells that were part of the granulomatous structure and the ones that remained solitary in the fibrous stroma were seen specifically in extirpated specimens. It was observed that in spite of the strong anaplasia of the tumor cells, the hyalinized connective tissues prevented infiltrative growth. It was concluded that the effectiveness of the therapy was dependent on the specific radiation dose and timing of the irradiation. (TSS) (NSA of Japan)

23578 PROTEINURIA IN HIROSHIMA AND NAGASAKI, JAPAN. Freedman, Lawrence R.; Seki, M.; Phair, John P.; Nefzger, M. D. (Atomic Bomb Casualty Commission, Hiroshima, Atomic Bomb Casualty Commission, Nagasaki). Yale J. Biol. Med., 40: 109-30(Oct. 1967).

A study of the epidemiology of proteinuria was conducted on about 5,000 persons comprising a portion of the clinical sample of residents of Hiroshima and Nagasaki under study at the Atomic Bomb Casualty Commission. In addition, data from previous examinations of similar samples were analyzed. Proteinuria was more common in Hiroshima than in Nagasaki. The rates for men and women did not differ within cities. Age-specific rates of proteinuria were peculiar, peaking in adolescence and old age. In the subjects under study, proteinuria was frequently inconstant and usually represented excretion of less than 1.0 gm of protein per day. Prior exposure to radiation as measured by distance from the bomb hypocenter was correlated with increased proteinuria rates in 18-year-old subjects who were in utero ATB. Subjects exposed after birth did not show this tendency. It was not determined whether this was an effect of in-utero irradiation and, if so, whether radiation resulted in renal disease by increasing the subject's susceptibility to the usual causes of glomerulonephritis or by some more direct mechanism. (C.H.)

23579 PROTECTION BY SEROTONIN–CREATININE SULFATE COMPLEX OF THE PLANARIA DUGESIA TIGRINA AGAINST THE LETHAL EFFECTS OF X-RAYS. Laguarda-Figueras, Alfredo; Villalobos-Pietrini, Rafael (Comision Nacional de Energia Nuclear, Mexico City. UNAM, Mexico City). Proc. Soc. Exp. Biol. Med., 126: 667-9(Dec. 1967).

The serotonin-creatinine sulfate complex (S-CS) at a concentration of 3.14×10^{-5} M protected the planarian Dugesia tigrina from the lethal action of x rays; the dose reduction factor was 1.88. Vasoconstriction and the subsequent lowering of oxygen tension inside the tissues was not involved in this observed radioprotection. (auth)

23580 POSTRADIATION RECOVERY OF SEEDS. Kuzin, A. M.; Runova, Yu. N.; Ladygina, V. G. (Inst. of Biophysics, Moscow). Radiobiologiya, 7: 909-12(1967). (In Russian).

Conditioned barley seeds containing 9% moisture were irradiated at doses of 25 to 30 kR of ^{137}Cs irradiation at a dose rate of 700 R/min. The irradiated seeds were then thoroughly washed with urea solution or water (control). A high level of mitotic activity was noted in all seeds; however, the percentage of chromosome aberrations in the urea washed seeds was considerably lower. (TSS) (JPRS)

23581 BONE LESIONS FOLLOWING POSTOPERATIVE RADIOTHERAPY FOR CANCER OF THE BREAST. Tagaya, Fumio (Tokyo Univ.). Nippon Igaku Hoshasen Gakkai Zasshi, 27: 173-203(May 1967). (In Japanese).

In the six years from 1954 to 1960, about 700 patients were subjected to radiotherapy after an operation for breast cancer. One hundred forty-four patients were followed by x ray photography and the results did not show the metastasis of cancer for over six months after radiotherapy. Of these 144, 15 patients had bone injury. The injuries ranged in their position from the clavicle to the fifth rib, corresponding exactly to the applied irradiation field. The period, after the end of irradiation, to the occurrence of bone injuries, was relatively short. As the irradiation voltage increased, the bone injuries also increased. The injuries, occurring in the ribs, were found not to affect the patient's daily life considerably. In the cases observed, the bone injuries were all accompanied by lung injuries and occurred in patients 48.3 avg. years of age. (NSA of Japan)

23582 RADIOSENSITIZING ACTION OF AMETOHEPAZON ON THE IRRADIATED TUMOR TISSUES. 2. PRELIMINARY CLINICAL REPORT. Abe, Masao; Tobe, Tatsuo (Gunma Univ., Japan). Nippon Igaku Hoshasen Gakkai Zasshi, 27: 995-1006 (Nov. 1967).

Combination therapy with Ametohepazon and radiation was attempted on 11 patients with malignant tumors. Early clinical observations confirmed Ametohepazon as a radiosensitizer; no adverse side effects were observed. Some patients showed general improvement. (TSS) (NSA of Japan)

23583 REDUCTION OF PERTECHNETATE AS A POSSIBLE CAUSE OF FAILURE BY THE THYROID GLAND TO ACCUMULATE ^{99m}Tc. Boerner, W.; Moll, E.; Rauth, E. (Univ., Wuerzburg, Ger.). Nucl.-Med., 6: 360-2(Oct. 15, 1967). (In German).

During the storage of eluted pertechnetate solution there is a risk of decomposition likely caused by a reduction of the septavalent technetium. This is recognized by a significantly increased adsorption of ^{99}Tc onto the glass and metal parts of the injection syringe. The new compound resulting from this alteration is not accumulated by the thyroid gland. (auth)

23584 RADIODIAGNOSTICS OF SIALOLITHIASIS. Benendo-Kapuscinska, B. Pol. Przegl. Radiol. Med. Nukl., 31: 547-53 (July-Aug. 1967). (In Polish).

The radiodiagnosis of sialolithiasis is based on plain radiograms and on sialography. The technique of examination and typical patterns of sialolithiasis in the plain radiograms and in sialograms are presented. The complications and sequelae of sialolithiasis are discussed in detail. The majority of cases concern the submandibular salivary gland, while the parotid gland stones are rare. (auth)

23585 SIMULTANEOUS USE OF TWO TRACERS FOR RADIOCARDIOGRAPHY. Martinenghi, C.; Tarolo, G. L.; Colombo, L.; Conte, L. (Univ., Milan). Radiol. Med., 53: 321-35(Apr. 1967). (In Italian).

Two tracers with gamma emission were injected in the form of a homogeneous mixture into the jugular vein of the subject. One was composed of ^{197}Hg-2-hydroxypropyl mercury-labeled erythrocytes that passed through all of the cardiac cavities resulting in a total radiocardiogram. The other was composed of ^{131}I-labeled albumin that was stopped by the capillaries of the pulmonary circulation resulting in a selective right radiocardiogram. The two recordings could be used to determine the cardiac output and to calculate the ventricular right volume. The pulmonary accumulation of ^{131}I made it possible to deduct the pulmonary radioactivity from the selective right radiocardiogram. (H.L.W.)

23586 QUALITY CONTROL OF RADIOPHARMACEUTICALS. Gopal, N. G. S.; Iya, V. K. (Bhabha Atomic Research Centre, Bombay). J. Sci. Ind. Res., 26: 153-8(Apr. 1967).

Physical, chemical, and biological methods of control of radiopharmaceuticals are considered. Physical methods include determinations of half-life and radiations emitted. Acceptable values for these properties are tabulated for the following radioisotopes: ^{198}Au, ^{82}Br, ^{57}Co, ^{58}Co, ^{60}Co, ^{51}Cr, ^{59}Fe, ^{197}Hg, ^{203}Hg, ^{131}I, ^{132}I, ^{42}K, ^{24}Na, and ^{32}P. Chemical methods include spectrophotometric analyses for determination of chemical purity and determination of carrier concentration of medical radioisotopes. Tables are presented showing values of these determinations. Control of radiochemical purity is carried out using paper chromatography and paper electrophoresis. Biological control consists of tests for pyrogens, sterility, and toxicity. (H.L.W.)

23587 POSTIRRADIATION KIDNEY ATROPHY IN A CHILD WITH MALIGNANT LYMPHOGRANULOMATOSIS. Jakubowska, D.; Ochocka, M.; Rysiakowa, K. Pol. Przegl. Radiol. Med. Nukl., 31: 621-7(July-Aug.)1967). (In Polish).

A case of long-lasting lymphogranulomatosis maligna in a child is presented. In the course of treatment of the abdominal lymph nodes the left kidney was in the irradiated area. One and a half years after the irradiation, symptoms of renal dysfunction appeared. The performed urography demonstrated postirradiation atrophy of the left kidney. (auth)

23588 ZAKLADY IZOTOPOWE Z ZAMKNIETYMI ZRODLAMI PROMIENIOWANIA GAMMA. WYMAGANIA OCHRONY PRZED PROMIENIOWANIEM JONIZUJACYM. (Isotope Laboratories for Sealed Gamma Radiation Sources. Requirements for

Protection Against Ionizing Radiation). PN-63/J-80102. Warsaw, Polish Standards Committee, 1964. 3p. 2.40 Zloty.

This standard specifies requirements for isotope laboratories in which sealed radioactive sources with a γ radiation equivalent of 50 mg Ra are employed for scientific, medical, industrial and other purposes: recommendations are made concerning planning, selection of location, protection of neighboring rooms and areas, safety devices and warning signs, dosimetry equipment and fire protection. The standard also includes special provisions concerning medical laboratories in which sealed sources are used therapeutically. The standard finally sets out requirements for the approval of plans for isotope laboratories and the approval of completed projects. (Occup. Safety & Health Abstr.)

23589 DEVICE FOR DIAGNOSING A PATIENT WITH RADIATION. Kurihara, Shigeyasu (to Tokyo Shibaura Electric Co., Ltd.). Japanese Patent 1966-19591. Sept. 13, 1966. Filed Aug. 29, 1963.

A device that uses oxygen-17 and xenon-133 and that can be used for radiodiagnosis of the functions of the heart and lungs was developed. A number of radiation detectors and their respective supports used in the machine tended to make it unwieldly. Several modifications were made to eliminate these drawbacks; these modifications are described. (TSS) (NSA of Japan)

Radiation Effects on Animals

Refer also to abstracts 23398, 23400–23405, 23413, 23414, 23416, 23419, 23422, 23426, 23428–23430, 23445–23447, 23449, 23454, 23456, 23458, 23459, 23467, 23477, 23479, 23481, 23486, 23490, 23504, 23509, 23510, 23532, 23536, 23537, 23560–23562, 23567–23570, 23574, 23576, 23579, 23693, 23699, and 23700.

23590 (BNL-12313) COLONY FORMING UNITS IN THE BONE MARROW OF PARTIAL BODY IRRADIATED MICE. Carsten, A. L.; Bond, V. P. (Brookhaven National Lab., Upton, N. Y.). Mar. 11, 1968. 16p. (CONF-680206-2). Dep. CFSTI.

From Symposium on Normal and Malignant Cell Growth, Chicago, Ill.

Results of experiments designed to investigate the relation between cell survival and survival of the irradiated animal are reported. Effects of partial body shielding on the colony forming unit (CFU) or stem cell content of the right hind leg were studied in mice subjected to whole-body and partial-body exposure to x radiation. In each case the number of CFU's per 60,000 nucleated cells was determined in the right hind leg. It is pointed out that data expressed as CFU's per unit of nucleated cells and that expressed as absolute number of CFU's per leg may lead to different conclusions. In relative terms, there was a marked and sustained increase in CFU's in shielded unirradiated marrow, but in absolute terms no such sustained over-shoot occurred. Appearance of a late aplasia is attributed to a slow turnover time of vascular cells in the marrow. The total marrow cellularity during the second period of marrow aplasia was close to normal, indicating that the remaining stem cells even though few in number, were capable of division and differentiation. Results indicated that the microenvironment in which stem cells find themselves may strongly influence the degree to which these cells can proliferate and the type of maturating cells that stem cells will produce. (H.G.D.)

23591 (COO-910-6) BOVINE LYMPHOCYTIC LEUKEMIA: STUDIES OF OCCURRENCE AND DISTRIBUTION INCLUDING INVESTIGATIONS OF FAMILIAL AND ENVIRONMENTAL FACTORS WITH SUPPORTING CLINICAL, HEMATOLOGIC, PATHOLOGIC, INDUCTION AND TRANSMISSION STUDIES. Progress Report No. 8. Sorensen, D. K. (Minnesota Univ., St. Paul. Coll. of Veterinary Medicine). Feb. 1, 1968. Contract AT(11-1)-910. 64p. Dep. CFSTI.

GENETICS — analysis of multiple case leukemia herds of cattle
BLOOD — analysis in single case leukemia herds and random cattle populations
CATTLE — lymphocytosis in, originating from multiple case herds
DISEASES, NEOPLASTIC — leukemia transmission of bovine, by inoculation of fetuses in utero
GAMMA RADIATION — effects on count of lymphocytes in cattle
DISEASES, NEOPLASTIC — leukemia, epidemiology of bovine, in Minnesota, analysis of statistics on (H.L.W.)

23592 (COO-1474-11) LONG TERM EFFECTS OF PRENATAL X-IRRADIATION ON CEREBRAL CORTEX. Technical Progress Report, December 1, 1966–December 1, 1967. Brizzee, Kenneth R. (Utah Univ., Salt Lake City. Coll. of Medicine). Jan. 1968. Contract AT(11-1)-1474. 35p. Dep. CFSTI.

BRAIN — radiation effects on blood vessels and neurons of, in rats, effects of age on x
PIGMENTS — distribution of autofluorescent, in cerebral cortex of rats
X RADIATION — effects on histology of brain following prenatal exposure of rats
BRAIN — radiation effects on fine structure of, in rats, effects of age on x (H.L.W.)

23593 (IA-1128) RESEARCH LABORATORIES ANNUAL REPORT FOR THE PERIOD JANUARY–DECEMBER 1966. (Israel Atomic Energy Commission, Tel Aviv). July 1967. 263p. Dep.

Separate abstracts were prepared for the research carried out by each section during the period January to December, 1966. (H.L.W.)

For abstracts of individual sections see: 23003, 23034, 23133, 23220, 23358, 23398, 23399, 23694, 24408, 24788, 24854, and 25128.

23594 (LF-38, pp 108-12) SOME BIOLOGICAL CHARACTERISTICS OF ^{90}Sr-INDUCED CHLOROLEUKEMIA IN HOLTZMAN RATS. (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.).

Holtzman rats, exposed to a soluble aerosol of ^{90}Sr, received an initial body burden of 100 to 200 μCi/kg. The initial hematopoietic depression in exposed animals was consistent with previous experiments. Two cases of chloroleukemia developed, one of which was successfully transferred to rat pups for maintenance purposes. It was found that intraperitoneally injected animals, less than seven days old, developed leukemia and had a mean survival time of 27 days, whereas animals injected subcutaneously developed localized tumors and lived for approximately 65 days. The effect of cell dilution and age of recipient at time of transfer, on mean survival and successful takes, was also investigated and is discussed in relation to other induced rat chloroleukemia studies. (auth)

23595 (LF-38, pp 139-43) ELECTROCARDIOGRAM AND PHONOCARDIOGRAM OF NORMAL ONE-YEAR-OLD BEAGLE DOGS. (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.).

As a portion of the clinical evaluation of beagle dogs exposed to fission product radionuclides via inhalation, electrocardiograms and phonocardiograms were recorded prior to and every two years after exposure. Evaluation of the duration and amplitude of nine electrocardiogram leads recorded on 115 to 177 apparently healthy 12- to 14-month old dogs is presented. Analysis of the phonocardiogram of 123 dogs for heart rate, duration of ventricular systole, and duration and number of vibrations of the first and second heart sounds, is presented. (auth)

23596 (LF-38, pp 144-6) ELECTROENCEPHALOGRAM OF NORMAL ONE-YEAR-OLD BEAGLE DOGS. (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.).

In order to detect abnormalities in the nervous system of beagle dogs exposed to fission-product radionuclides via inhalation, electroencephalograms were recorded prior to and annually after exposure. The results of the analyses for frequency and amplitude of 155 apparently normal recordings obtained at 12 to 14 months of age are presented. The recordings considered abnormal are briefly discussed. (auth)

23597 (MIT-3045-34) AUTORADIOGRAPHIC INVESTIGATION OF BRAIN METABOLISM UNDER NORMAL, EXPERIMENTAL, AND PATHOLOGICAL CONDITIONS. Annual Progress Report, June 1967–June 1968. Altman, Joseph (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-3045. 23p. Dep. CFSTI.

A complete, standardized collection of serial autoradiograms from the brains of rats injected with ^{3}H-thymidine at different ages (from birth to adulthood) and killed at different intervals after injection (from 1 hour to 8 months) was prepared. Postnatal gliogenesis in this material and the evaluation of autoradiograms from animals injected as adolescents or adults, and from animals that survived for prolonged periods after injection were studied. These studies indicated that the acquisition of cells in several brain regions proceeds sequentially in a hierarchic manner. Macroneurons, the long-axoned core elements of the brain, are formed first and prenatally (according to recent findings from our laboratory some of the macroneurons of the basal ganglia are still formed in neonates). Microneurons, the short-axoned interneurons, are formed next, in many brain regions predominantly after birth. Neuroglia are formed last, in some brain regions beginning in the third week of life. The sequential origin of different types of neurons in the cerebellum was also investigated, where the following order was established: neurons of deep

cerebellar nuclei → Purkinje cells → Golgi cells (prenatally); basket cells → stellate cells → granule cells (postnatally). About half of the granule cells are formed during the third week. The effects of irradiation of the cerebellum during early postnatal development with repeated daily doses of low-level x ray were studied. The data indicate that an increasing proportion of the basket, stellate, and granule cells of the cerebellum were destroyed with increased number of daily doses of x ray. With eight or ten daily exposures to 200 R the cerebellum develops essentially devoid of microneurons but with a full complement of prenatally-formed Purkinje cells. Behavioral studies in progress suggest that with increasing number of irradiations the locomotor deficits produced become more pronounced, 8 or 10 × 200R producing permanent ataxia. (auth)

23598 (UCRL-17481, pp 154-70) ROLE OF CAPILLARIES IN THE PATHOGENESIS OF DELAYED RADIONECROSIS OF BRAIN. McDonald, Larry W.; Hayes, Thomas L.

Increase in capillary basal lamina thickness is regularly seen from one to three months following proton or alpha particle irradiation of the rabbit brain. This thickening is present in areas adjacent to radionecrotic tissue. Radiation changes that appear in areas not related to necrotic tissue include endothelial- and perivascular-cell edema. The number and size of cytoplasmic vacuoles and inclusions is increased. Splitting of capillary basal lamina is present, but thickening of basal lamina is not so marked as in areas adjacent to necrotic tissue. The scanning electron microscope and a large-block recovery method for transmission electron microscopy were used to show that the capillary changes are limited to the irradiated area and that capillary basal lamina thickening is found primarily in areas adjacent to necrotic tissue. (auth)

23599 (UCRL-50376) THE CHANGING FREQUENCY OF THYROID CARCINOMA AND HASHIMOTO'S THYROIDITIS AS RELATED TO DIAGNOSTIC CRITERIA, IODIZED SALT, AND RADIATION. Chapman, William H. (California Univ., Livermore. Lawrence Radiation Lab.). Jan. 12, 1968. Contract W-7405-eng-48. 36p. Dep. CFSTI.

The incidence of thyroid carcinoma and of Hashimoto's thyroiditis are reported to be increasing both in series of surgically treated patients and in the number of cases of these diseases diagnosed in the younger age groups. An evaluation of these data, including the determination of whether or not the increase in the incidence of each disease is apparent or real and consideration of the factors possibly responsible for the reported increases is presented. In the surgical treatment of either disease, it can be shown that a considerable fraction of the reported increase is apparent only, and is largely a reflection of the decreasing number of thyroid operations performed for thyrotoxicosis and the use of more rigid diagnostic criteria in the selection of patients for surgery. The increasing number of cases of thyroid carcinoma diagnosed in younger persons are considered with respect to the effects of iodized salt and the use of x radiation for thymic enlargement, since the former was introduced and the latter was in vogue at the time the older members of this age group were in infancy. The overall frequency of goiter has decreased with the use of iodized salt and, concurrently, a greater proportion of the nodular lesions of the thyroid are found to be malignant. In the case of thymic irradiation, it is shown that the reported increase in thyroid carcinoma in young persons is the result of this factor, however, there is not sufficient evidence to implicate thymic irradiation as solely responsible for the increase. With regard to the increase in the number of cases of Hashimoto's thyroiditis diagnosed in the young, the data indicate that a genuine increase occurred in the frequency of the disease following the introduction of iodized salt, and that an apparent rather than a real increase occurred with the availability of improved diagnostic methods and recognition of the prevalence of the disease as a cause of nontoxic nodular goiter. On the basis of the existing data it is difficult to attribute any of the increase in the frequency of the disease to radiation. (auth)

23600 (N-67-18922) HISTOLOGIC CHANGES IN THE INNER EAR OF ANIMALS EXPOSED TO X-IRRADIATION. Ivanov, N. I. Translated from Vestn. Ororino-Laringol., 18: 78-83(1957). 8p. (NASA-TT-F-10497). CFSTI.

Following x irradiation (either general or local exposure) of rabbits and guinea pigs in the region of the ear, the animals were kept under observation for some time and then killed. The x ray doses used (total local dose: 2 × 1000 R, total general dose: 300 or 600 R) induced traumatic effects as well as pathologic changes in the middle and inner ears of these animals. The organ of Corti was the most sensitive to x radiation. Reaction to the traumatic effect could clearly be noted as labyrinthitis. (auth)

23601 REMOTE GENETIC EFFECT OF IONIZING RADIATION. Yasnova, L. N. Izv. Sib. Otd. Akad. Nauk SSSR, Ser. Biol.-Med. Nauk, No. 5, 136-46(Apr. 1967). (In Russian).

A bibliographic review of the remote genetic effects of ionizing radiation is presented. The detection of remote genetic effects, the possible nature of radiotoxins, remote genetic effects as a possible result of the destruction of key fermentation processes, and the possible role of thiol groups were discussed. (84 references) (J.S.R.)

23602 MOUSE-STRAIN DIFFERENCES IN ENDOGENOUS COLONY FORMATION AFTER IRRADIATION IN HYPOXIA. Vacek, A.; Sugahara, T. (Kyoto Univ.). Int. J. Radiat. Biol., 12: 579-81(1967).

An attempt was made to determine whether differences in radiosensitivity and radioprotection among various strains of mice are reflected in the colony-forming ability of the spleen. Mice were irradiated with 50 R/min x rays during environmental hypoxia. Endogenous spleen colonies (ESC) were counted in spleen harvested and fixed 10 days after irradiation. Dose-dependence curves of ESC in mouse strains dd/YF and DBA/2 had a D_0 of 50 R for air and 200 R in 8% O_2. Strains RF and CF #1 had a D_0 of 40R for air and 80 R in 8% O_2. Reduction of the barometric pressure during irradiation in 8% O_2 had no effect on the ESC count. The ^{59}Fe incorporation in femur and spleen was not increased within four days after exposure to the maximal time of acute hypoxia (20 min in 8% O_2). The observed differences among strains may be due to the intensity of protection of bone-marrow cells by hypoxia with subsequent migration of marrow cells to the spleen where they form colonies. (M.M.B.)

23603 X-IRRADIATION OF SPLENIC LYMPHOCYTES. I. THYMIDINE POOLS AND RADIOTHYMIDINE INCORPORATION INTO DNA. Adelstein, S. J.; Manasek, Gretel B. (Harvard Medical School, Boston). Int. J. Radiat. Biol., 12: 587-91(1967).

An attempt was made to elucidate the mechanism of the suppression of tritium-labeled thymidine incorporation into the DNA of irradiated splenic lymphocytes. Cell suspensions were prepared from the spleens of golden hamsters. From autoradiographs it was determined that most of the DNA synthesis takes place in medium-sized lymphocytes. After x irradiation the uptake of tritium-labeled thymidine at various concentrations was measured. From kinetic analysis no evidence was obtained for the expansion of thymidine pools immediately following 15 krad, nor that such an increase could be the proximate cause for the depressed incorporation of tritium-labeled thymidine into DNA. (M.M.B.)

23604 X-IRRADIATION OF SPLENIC LYMPHOCYTES. II. DIFFERENTIAL INCORPORATION OF PYRIMIDINE NUCLEOTIDE PRECURSORS INTO DNA. Adelstein, S. J.; Manasek, Gretel B. (Harvard Medical School, Boston). Int. J. Radiat. Biol., 12: 593-5(1967).

X-irradiation of splenic lymphocytes from hamsters results in an immediate diminution in the incorporation of tritium-labeled thymidine by the DNA. The incorporation of various labeled compounds into the nucleic acids of lymphocytes irradiated in vitro with 15 krad of x rays at 23°C was studied. Neither the uptake of tritium-labeled orotic acid nor of ^{32}P-labeled orthophosphate was significantly affected by irradiation. However, the uptake of uridine was depressed about 55% while various deoxynucleosides were depressed to varying degrees. Since the main pathway to nucleotide synthesis was unaffected by doses that affect nucleoside-incorporation, it was emphasized that caution must be exercised in using nucleoside-incorporation rates as a reflection of rates of DNA synthesis. (M.M.B.)

23605 RADIATION-CONDITIONED AVERSION IN RATS AFTER PART-BODY X-IRRADIATION AND ITS RELATIONSHIP TO GASTRIC EMPTYING. Hulse, E. V.; Mizon, L. G. (MedicalResearch Council, Harwell, Eng.). Int. J. Radiat. Biol., 12: 515-22(1967).

Rats irradiated shortly after eating a barium meal may refuse to eat a second barium meal when tested 4 to 6 weeks later. Irradiation of the abdomen was about 60% as effective as whole-body irradiation in producing this aversion, but irradiation of the head and shoulders was only 20% as effective. Irradiation of parts of the abdomen readily produced aversions, but irradiation of the pelvis did not. The strength of the aversion was closely correlated to the severity of the radiation-induced delay in gastric emptying that was observed when the initial barium meal was given. It was concluded that gastric delay was normally the prime cause of the aversions. The few exceptions suggested that a further, possibly humoral, factor may also be involved when extra-abdominal tissues are irradiated. (auth)

23606 SURVIVAL CURVES FOR CLONOGENIC CELLS OF A MURINE KERATINIZING SQUAMOUS CARCINOMA IRRADIATED

IN VIVO OR UNDER HYPOXIC CONDITIONS. Hewitt, Harold B.; Chan, Daniel P.-S.; Blake, Eileen R. (Mount Vernon Hospital, Northwood, Eng.). Int. J. Radiat. Biol., 12: 535-49(1967).

In its histological character and tendency to metastasize preferentially to lymph nodes, this tumour is indistinguishable from its clinical homologue. Of the morphologically intact cells released from the tumours by enzymatic treatment, 17 were required for 50% successful transplantation to synergeic hosts; this figure was reduced to four when a preponderance of radiation-killed cells was added to the inocula. The survival curve for cells of tumours irradiated in situ under hypoxic conditions gave D_0 = 340 R and n = about 2.0. The distribution of cell-survival values for tumours irradiated in vivo indicated that about 18% of the viable tumour cells are hypoxic in vivo. Four out of five different stromated tumours for which similar data have been reported had between 15 and 21% of their cells hypoxic in vivo. An attempt is made to explain these striking similarities in terms of a common micro-anatomical unit with dimensions referred to the limiting distance of diffusion of oxygen from a capillary into respiring tissue, as calculated by Thomlinson and Gray (1955). (auth)

23607 RESPIRATORY CAPACITY AT REST AND DURING PHAGOCYTOSIS OF RAT POLYMORPHONUCLEAR LEUKOCYTES UNDER VARIOUS CONDITIONS OF IRRADIATION. Turcu, Gr.; Aibu, A. St. (Inst. of Medicine and Pharmacy, Bucharest). Int. J. Radiat. Biol., 12: 505-13(1967).

The respiratory capacity of polymorphonuclear (PMN) leukocytes, at rest and during phagocytosis, was determined after various conditions of irradiation. The PMN leukocytes were obtained from the peritoneal cavity of rats in which an aseptic peritonitis was induced 24 hours before killing. Experimental results showed a considerable decrease in the respiratory capacity, both at rest and during phagocytosis, of the PMN leukocytes from animals irradiated with 1200 R; an obvious lowering in the respiratory capacity of the PMN irradiated in vitro with 2000 R; an increase in respiration during phagocytosis of the PMN from animals irradiated internally with 1 μCi ^{32}P/g and killed on the third day, and a diminution of it in PMN from animals killed after 6, 12, and 20 days; a normal respiratory capacity of PMN which phagocytize in the presence of a homologous serum taken from animals irradiated with 1200 R and of a serum irradiated in vitro with 5000 R. (auth)

23608 DETECTION OF THE ORIGIN OF ERYTHEMA-RELEASED MATERIAL IN THE SKIN INDUCED BY UV-IRRADIATION. Tronnier, Hagen (Univ., Tuebingen, Ger.). Strahlentherapie, 134: 625-8(Dec. 1967). (In German).

Based on previous investigations it was presumed that substances were produced in the stratum corneum of human skin during uv irradiation which are important for the occurring of erythema. Results are reported from studies that showed that removal of parts of the stratum corneum decreased the erythema reaction; laying the scrapings of the irradiated stratum corneum on the skin again, resulted in an increase of the reaction; erythema was increased even by scrapings of non-irradiated stratum corneum compared to the one occurring at the skin where the stratum corneum had been scraped off; and scrapings of the irradiated stratum corneum causes a short-time erythema reaction even in the non-irradiated skin. (auth)

23609 COMBINED ACTION OF ^{90}Sr AND CHEMICAL CARCINOGENS. Zapol'skaya, N. A.; Lavrent'ev, L. N.; Fedorova, A. V. Radiobiologiya, 7: 376-80(1967). (In Russian).

Rats received injections of ^{90}Sr at a dose of 8×10^{-3} μCi per day for two months or 2×10^{-4} μCi for 7 months. The radioactive isotope as such did not produce tumors at these doses. After 0.2 mg of the carcinogen, 9,10-dimethyl-1,3-benzanthracene, was injected into the bone marrow channel of the femurs of rats, tumors of the thigh and in other parts of the body developed at a much higher rate and with greater severity than in rats treated with the carcinogen alone. (JPRS)

23610 STUDY OF THE PHAGOCYTIC AND DIGESTIVE FUNCTIONS OF THE RETICULOENDOTHELIAL SYSTEM UPON IRRADIATION WITH AGGREGATED ALBUMIN LABELLED WITH ^{131}I. Kendysh, I. N. Radiobiologiya, 7: 372-5(1967). (In Russian).

Rats injected intravenously with aggregated human albumin labeled with ^{131}I were irradiated at a dose of 750 R. The phagocytic function of the reticuloendothelial system in taking up the albumin, as indicated by the decrease of ^{131}I activity in the blood and its increase in the liver and spleen, was not affected by irradiation. Seven days after irradiation, the ^{131}I activity in the liver and spleen showed a decrease compared with non-irradiated control animals. There was no corresponding decrease in ^{198}Au activity in the spleen and liver after labelled colloidal gold, which is phagocytized by the reticuloendothelial system, but not further metabolized, had been administered to the rats. This indicated that the decrease in ^{131}I activity was not due to migration of the labelled albumin into other organs, but to stimulation of the proteolytic (digestive) capacity of cells of the reticuloendothelial system by irradiation. (JPRS)

23611 INDUCED CHANGES IN THE MITOTIC ACTIVITY OF HEMOCYTES OF THE LARGE MILKWEED BUG, ONCOPELTUS FASCIATUS. Feir, Dorothy; McClain, Elizabeth (St. Louis Univ.). Ann. Entomol. Soc. Amer., 61: 416-21(Mar. 1968).

Circulating hemocytes of Oncopeltus fasciatus are known to exhibit a measurable amount of mitotic activity. The mitotic index was employed as the criterion of response to various treatments involving factors which might affect this activity. Bleeding, injury, and adrenaline were found to increase the mitotic activity; these effects were seen during the 48th to 72nd hour of the fifth nymphal stadium. Cobalt-60 γ radiation blocked mitotic activity at the metaphase stage. (C.H.)

23612 INCIDENCE OF ENDOGENOUS BACTERIAL INFECTION IN MURINE RADIATION CHIMERAS WITH SECONDARY DISEASE. Watson, James R.; Hammond, Carolyn W. (Univ. of Illinois, Chicago). Radiat. Res., 32: 581-6(1967).

Pathological changes indicative of bacterial infection have been reported by several investigators in animals with secondary disease. Cultural methods were used in experiments to determine whether bacterial infection actually does occur in chimeras with this syndrome. Four hundred and twenty-one specific-pathogen-free (SPF) mice showing well-developed secondary disease were sacrificed between days 29 and 52 postirradiation. Their livers and spleens were excised and homogenized in tissue grinders. The organ homogenates and a drop of heart's blood from each mouse were cultured on bacteriological media both aerobically and anaerobically. Fifty-seven percent of the animals had positive liver cultures, 41% had positive spleen cultures, and 25% had bacteremia as indicated by positive heart's blood cultures. The organisms cultured from these organs were usually members of the chimeras' enteric flora.

23613 POSSIBLE EFFECT OF RADIATION PRODUCED HYDROGEN PEROXIDE ON POST-IRRADIATION AVERSION IN MICE. LeVan, H.; Moos, W. S. (Univ. of Illinois, Chicago). Experientia, 23: 749-51(Sept. 15, 1967).

Tap water, solutions of saccharin and sucrose were x-irradiated and it was noted that the avoidance behavior of mice towards these solutions resembled the avoidance behavior of x-irradiated mice towards unirradiated saccharin solutions. In other experiments, hydrogen peroxide was added to tap water and solutions of saccharin and sucrose and avoidance behavior was observed. It is thought that hydrogen peroxide is a radiolytic product of water and aqueous solutions, and that this induces the avoidance behavior in mice. (H.L.W.)

23614 ANIMAL EXPERIMENT INVESTIGATIONS OF RADIATION DAMAGE TO THE BLOOD-LYMPH BARRIER. Wende, Sigurd (Freie Univ., Berlin). Strahlentherapie, 134: 529-32 (Dec. 1967). (In German).

Animal experiments with rabbit serum albumin labeled with ^{131}I were used to determine the radiation dose that produced a permeability disturbance of the blood-lymph-barrier. Conventional x ray therapy (180 kV) and ^{60}Co irradiation of the brain showed the same results. This permeability disturbance was observed with lower x ray doses when the spinal marrow was irradiated. (auth)

23615 TRANSFORMATION OF LABELLED GLUTAMIC ACID IN THE BRAIN TISSUE OF AN IRRADIATED MOUSE. Jovanovic, Milan; Cordie, Ana (Boris Kidrich Inst. of Nuclear Sciences, Belgrade). Strahlentherapie, 134: 533-5(Dec. 1967).

The transformation of labeled glutamic acid was observed in brain tissue of γ irradiated mice. A high specific activity of glutamic acid and low specific activity of GABA and glutamine were determined immediately after irradiation. In the first four days after irradiation the values of the specific activity of glutamic acid decreased and the values of the specific activities of their direct metabolites increased. It was concluded that the systems in which glutamic acids are transformed into GABA and glutamine are not equally sensitive to irradiation. (auth)

23616 CORTICOSTEROID CHANGES AFTER WHOLE-BODY IRRADIATION. A REPORT ON THE ENDOCRINIC EFFECTS OF X RADIATION. Flemming, Kurt (Univ., Freiburg i. B. Heiligenberg-Inst., Ger.). Strahlentherapie, 134: 565-73(Dec. 1967). (In German).

A biphasic increase of the corticosteroid content was observed in the adrenals, the venous blood of the adrenals, and in the peripheral blood of rats after whole-body x irradiation (750 to 1000 R).

The first increase was observed 2.5 hours after irradiation, the second one reached its maximum 72 hours after irradiation. Both of these increases could be inhibited by cysteamine. The corticosteroid increase was dose dependent between 250 and 1000 R. The changes in the adrenal and the blood were the same. There was no reason to believe that a secretion inhibition of the adrenal cortex was involved. The increase of the glucocorticosteroids was larger than the one of the mineralocorticoids. It is assumed that this qualitative difference is very important for the evaluation of the adrenal cortex function after whole-body irradition. (auth)

23617 INFLUENCE OF THE INGREDIENTS PRESENT IN INDIA INK UPON THE PHAGOCYTOSIS AND SURVIVAL OF IRRADIATED RATS. Antonijevic, Milos (Boris Kidric Inst. of Nuclear Science, Belgrade). Strahlentherapie, 134: 585-9 (Dec. 1967).

Different effects caused by ingredients present in India ink on phagocytosis of carbon particles and survival of rats exposed to 200 R were demonstrated. It was found an increased phagocytic activity with the only difference that the values of global phagocytic index in irradiated rats treated with fish glue-containing carbon suspension were on higher level during the first two days of examination. The course of the survival of irradiated rats is quite different. While rats injected with carbon suspension containing fish glue as ingredient survived 100%, in rats tested with carbon suspension that contained shellac, mortality amounted from 17% to 83% depending on the time at which the injection of carbon was performed after irradiation. These findings suggest that shellac present in commercial India ink, is responsible for death of the irradiated rats. (auth)

23618 INFLUENCE OF X RADIATION ON THE FITNESS CHARACTERISTICS OF DROSOPHILA MELANOGASTER. II. INVESTIGATIONS ON FECUNDITY. Noethel, Horst (Freie Univ., Berlin). Strahlentherapie, 134: 609-24(Dec. 1967). (In German).

The influence of x rays (100 kV, 13 different doses within the range of 0 to 100 kR) on fitness components of adult insects was studied by means of the fecundity of D. melanogaster. In the unirradiated controls, the oviposition rate was maximal 3 days after T_0 and, later on, decreases steadily. After irradiation, the premortal sterility period increases logarithmically from 1 to 2 days at 0 kR to 30 days at 6 kR. The total productivity between exposure and death decreases in this range accordingly. However, even at 100 kR some eggs are laid. After irradiation of the various cysts, the oviposition rate showed distinct maxima and minima. After exposition of oogonia, there was a constant relation between postirradiation and control rate at each dose. The dose effect curve was sigmoid. Complete sterility was induced at 8 to 11 kR. A fecundity of 50% of the controls was found at 3.3 kR in the Berlin wild-stock and at 6.1 kR in the Berlin wild-stock-60. General radiation effects in the females did not influence the oviposition rate, except for a central nervous injury induced at 100 kR. However, radiation effects on oogenesis were apparent when the time course of oogenesis was paralleled with the fecundity in the time after exposure: The processes of yolk formation were resistant. The stages with a high chromatine increase were very sensitive, probably due to blocking the DNA-synthesis and/or to chromosome aberrations. These damages resulted in different effects depending on the cells in which they were induced. In the oogonia and the nurse-cells of the oocyte stages, they resulted in a decrease of fecundity. In the oocytes, they resulted in a decrease of the developmental rate of the eggs laid. (auth)

23619 STUDIES ON LYMPHOCYTES. VIII. SHORT IN VIVO MITOTIC TIME OF BASOPHILIC LYMPHOID CELLS IN THE THORACIC DUCT OF CALVES AFTER SIMULATED OR EFFECTIVE EXTRACORPOREAL IRRADIATION OF CIRCULATING BLOOD. Cunningham, L.; Cottier, H.; Cronkite, E. P.; Jansen, C. R.; Rai, K. R.; Safier, S.; Wagner, H. P. (Bern Univ.). Exp. Cell Res., 47: 479-88(Sept. 1967).

After cannulation of the thoracic duct of calves and after a single intravenous injection of tritium-labeled-thymidine, the mitotic time of lymphoid cells with a more basophilic cytoplasm was evaluated in vivo by removing lymph samples at 10 min intervals during two hr and by measuring time intervals between prophase and telophase index curves. After conversion of midprophase-midtelophase time to mitotic time, mitosis was found to last between 16 and 18.7 min. Mitotic time of lymphoid cells with a more basophilic cytoplasm was almost identical in the three calves studied and was not influenced by 48 hr of extracorporeal irradiation of the circulating blood. (auth)

23620 EFFECT OF AGE ON TWO MODES OF RADIATION DEATH AND ON HEMATOPOIETIC CELL SURVIVAL IN THE MOUSE. Yuhas, John M.; Storer, John B. (Jackson Lab., Bar Harbor, Maine). Contracts AT(30-1)-3314; DA-49-193-MD-2289. Radiat. Res., 32: 596-605(1967).

Female C57BL/6J mice, between the ages of 3 and 24 months, have been tested for three measures of radiosensitivity: marrow death, intestinal death, and hematopoietic stem cell content and survival, as estimated by the ability to form spleen colonies. The two modes of death show dissimilar aging patterns: marrow resistance increases to a maximum at 17 to 19 months of age, while intestinal resistance declines from 3 months onward. The median lethal dose for 30-day survival is a composite of sensitivity to both modes of death, with intestinal sensitivity becoming increasingly important as the age of the mouse is increased. The resistance to marrow death is accounted for by the number of stem cells present in the femoral marrow of the aging mouse, and by the surviving number after x-ray exposure. As was the case with resistance to marrow death, the number of stem cells in the femur increased through 18 months and declined thereafter. (auth)

23621 COMPARATIVE EFFECTS OF PENETRATING RADIATION ON THE CHOLINERGIC AND ADRENERGIC STRUCTURES OF THE BRAIN STEM. Makusheva, V. P. Radiobiologiya, 7: 422-4(1967). (In Russian).

The effect of irradiation of the head of rabbits and rats with 400 R of x rays and of the head of pigeons with 2500 R of x rays on the cholinergic and adrenergic structures of the brain stem was investigated by determining changes in the frequency of blinking on administration of phenamine and arecoline. The results showed that both cholinergic and adrenergic structures were affected by irradiation of the head. No changes in the reaction to arecoline were exhibited by pigeons after irradiation, apparently because of the high resistance of pigeons to the effects of radiation. The blinking reaction to phenamine set in earlier and persisted longer than the reaction to arecoline. This indicated that the adrenergic structures of the brain stem were affected by ionizing radiation to a greater extent than the cholinergic structures. (JPRS)

23622 ROLE OF SOME PHYSIOLOGICAL STIMULANTS OF THE INTESTINE IN THE RESPONSE OF WALL DIGESTION TO GENERAL IRRADIATION WITH X-RAYS. Bulbuk, G. A. Radiobiologiya, 7: 411-16(1967). (In Russian).

The effect of interruption of the flow of bile by tying off the bile duct on wall digestion in the small intestine of rats irradiated with 500 R of x rays was studied. Bile is known to aggravate the intestinal syndrome in the upper part of the small intestine in acute radiation sickness. Interruption of the flow of bile in irradiated animals reduced the intensity of wall digestion in the small intestine with respect to the hydrolysis of saccharose, but this effect was less pronounced in the upper part of the intestine than in animals with a normal bile flow. As a result there was a smoothing out of differences between the upper and lower part of the intestine in regard to the degree to which wall hydrolysis of saccharose was reduced in comparison with irradiated animals that had a normal bile flow. Assimilation of saccharose introduced into the intestine of irradiated animals proceeded more slowly in comparison with non-irradiated controls and involved greater participation of the lower part of the intestine, which was stimulated by the greater amount of undigested contents of the upper part of the intestine reaching it. (JPRS)

23623 GLYCOGEN INFLUENCE OF GLYCEMIA DURING RADIATION SICKNESS. Karaev, A. I.; Kuznetsov, B. G. Dokl. Akad. Nauk Azerb. SSR, 23: No. 5, 64-7(1967). (In Russian).

Rabbits were exposed to x radiation doses of 800 R. Glycogen was injected before irradiation and 7, 14, 21, and 30 days after irradiation. The injection of glycogen caused hyperglycemia within five minutes after introduction. It attained a maximum within 15 minutes and then within 45 minutes returned to the original level. In the early period of radiation sickness the injection of glycogen caused a phase change of the glycemia that was shown by the disturbance of the homeostatic system of glycemia. In the period of acute radiation reactions the introduction of glycogen caused a significant decrease of hyperglycemia during the simultaneous increase of the hypoglycemic phase. This resulted from the depression of the glycogenolytic processes in the liver and the disturbance of the compensatory function of the organism. (tr-auth)

23624 MODIFICATION OF RADIOSENSITIVITY OF THE SPERMATOGENIC EPITHELIUM IN MICE LIVING UNDER CONDITIONS OF INCREASED RADIATION. Zhorno, L. Ya.; Surikova, K. K. (Leningrad Research Inst. of Radiation Hygiene). Byull. Eksp. Biol. Med., 64: No. 12, 82-4(Dec. 1967). (In Russian).

Changes in the epithelium of the testes of eight consecutive generations of mice, each of which was kept in the area subjected to γ radiation ^{60}Co (20 mR/daily) for 6 months, were studied. It

was shown that rapidity of regeneration of the semen layer of seminal canals, after additional irradiation of 600 and 400 R, was different as compared to mice that were subjected to the same radiation. (auth)

23625 PATHOLOGICAL CHANGES IN THE TEETH AND TOOTH APPENDAGES OF THE RAT IN RADIATION SICKNESS. Korthals, E.; Obersztyn, A.; Dominikowski, M. Pol. Med. J., 6: 1198-1205(1967).

Translated from Czas. Stomatol., 19: No. 8, (1966).

Gamma radiation from a ^{60}Co source in doses of 600, 900, and 1200 R was given to 80 white rats. The 1200 R dose was lethal to all animals, while three of ten rats survived after the 900 R dose, and all rats survived after 600 R. On the 12th day after the 900 R dose and on the 35th day after the 600 R dose destruction of the epithelial attachments, periodontal membrane, and interdental septa was observed, with inflammatory reaction and epithelium proliferation occurring 35 days after irradiation. In some rats disturbances of dentine formation and pulp congestion was noted independently of the applied dose. (auth)

23626 A HISTOLOGICAL STUDY OF CERVICAL CANCER OF THE UTERUS AFTER TELECOBALT IRRADIATION WITH A SPECIAL REFERENCE TO THE CHANGE OF THE UTERINE CERVIX AFTER PREOPERATIVE IRRADIATION. Matsuura, Yakuji (Kobe Univ., Japan). Nippon Sanka Fujinka Gakkai Zasshi, 18: 1445-54(Dec. 1966). (In Japanese).

Histological analyses were made on the cancerous and surrounding tissues of extirpated uterine cervix of 91 patients who underwent preoperative radiotherapy. The ED_{90} obtained from a Probit regression line of the percentage cancer tissue degeneration to the exposure dose was 5560 R. The radiosensitive cancer could be distinguished from the radioresistant one at a dose of 5000 R. If the dose was further increased, a marked rise of the effectiveness could not be expected. Connective tissues in stroma increased with the dosage and the cancer tissue degeneration. The cell infiltration did not increase even if the dose was increased, but it tended to increase when the cancer tissue degeneration was severe. A marked thickening of the wall and a stenosis in blood vessels were caused by irradiation; however, the cancer tissue surrounded by many blood vessels was radiosensitive. From the histological findings of preirradiative biopsy and postirradiative section, it was shown that there was no relationship between the differentiation of cancer cells and the radiosensitivity, but that cancer tissue with the remarkable proliferation of connective tissue in stroma and the augmented cell infiltration was radioresistant. (NSA of Japan)

23627 NEOPLASIA RESULTING FROM GRENZ RADIATION. Brodkin, Roger H. (New Jersey Coll. of Medicine and Dentistry, Jersey City); Bleiberg, Jacob. Arch. Dermatol., 97: 307-9(Mar. 1968).

Grenz radiation (low-voltage x radiation) induced chronic radiodermatitis, a squamous cell carcinoma, and keratoses in a patient treated for psoriasis vulgaris during a 10-yr period. The treatment consisted of applications of uv radiation on the arms; followed by applications of salicylic acid, ammoniated mercury ointment and superficial x-ray therapy on the abdomen and arms; followed by application of grenz rays to the posterior surfaces of the thighs and buttocks. The grenz radiation (half-value layer 35 μ Al) was given in doses of 200 R/week for a total of 4,400 R to each area, followed one month later by another course of radiotherapy that totaled 5,800 R administered over a period of eight months, followed after a lapse of three months by a course of radiotherapy, during which 3,400 R was administered over a four-month period. A total of 13,000 R x radiation was administered to each area before the treatment was discontinued when acute dermatitis developed. A squamous cell carcinoma was removed from the buttock. Nodules removed at a later date were diagnosed as keratoses. (C.H.)

23628 RENAL VESSEL HISTOPATHOLOGY IN CHRONIC RADIATION AFFECTION WITH ^{210}Po. Astapova, S. A. Arkh. Patol., 29: No. 12, 8-14(1967). (In Russian).

A study was made of morphological changes occurring in renal vessels of male rats following a single intraperitoneal injection of neutral ^{210}Po solution in bismuth at a dose of 0.005 MCi/gm. Investigations were carried out both at the early periods of radiation injury (the 3rd and the 15th day), and at the later periods (the 50th, the 100th, 200th, 300th, 400th, and 500th day). All portions of the renal vascular network were injured in the animals. The most afflicted were glomerular capillaries and arterioles, especially in the subcapsular portions of the cortex. Degenerative-necrotic lesions of the walls of the arteries, veins, and capillaries, with disturbance of their permeability, were prevalent at the acute phase of radiation injury. Sclerotic lesions of the vessels and of the surrounding connective tissue, combined with endothelial proliferation, were characteristic of subacute and chronic ^{210}Po injury. In the genesis of radiation nephrosclerosis that developed in all of the rats injected with 0.005 mCi/gm of ^{210}Po, the principal role was played by injury to the vascular network of the kidneys. (auth)

23629 DAMAGE TO CELLS BY IONIZING RADIATIONS. Rugh, R. (Columbia Univ., New York). Contract AT(30-1)-2740. Atompraxis, 14: 13-17(Jan. 1968).

Various aspects of the effects of ionizing radiations on cells are reviewed. Damaging effects of radiation on germ cells, zygotes, and early embryos of mammals are described. Emphasis is placed on radiosensitivity of the developing nervous system. Effects on mitosis and the relation between chromosomal DNA and cytoplasmic differentiation of proteins are discussed, and a diagram of the cell showing organelles and their role in these relationships is presented. (H.L.W.)

23630 FOCAL HEPATIC INJURY AND REPAIR PRODUCED BY LASER RADIATION. PATHOLOGIC AND BIOPHYSICAL STUDIES. Fine, Samuel; Edlow, Jules; MacKeen, Donald; Feigen, Larry; Ostrea, Enrique; Klein, Edmund (Northeastern Univ., Boston. Harvard Medical School, Boston. Roswell Park Memorial Inst., Buffalo). Amer. J. Pathol., 52: 155-76(Jan. 1968).

A technique is described in which laser irradiation is used to produce an in vivo focal necrosis of the liver of the 100-gm rat. This was accomplished by directing the radiation through the intact muscle of the abdominal wall, thus avoiding direct contamination of the peritoneal cavity. Some of the thermal and optical events occurring in the abdominal muscle and liver during laser radiation are presented in an effort to relate these events to the genesis of the lesion. The initial and evolving gross and histopathologic changes of the lesion are described. The use of this technique may offer some advantages in the study of in vivo hepatic necrosis, autolysis, and repair. (auth)

23631 SOME EFFECTS OF X-IRRADIATION ON CIRCULATING EOSINOPHILS IN RATS: A SHORT COMMUNICATION. Lott, James R. (North Texas State Univ., Denton). Contract AT(40-1)-3270. Tex. Rep. Biol. Med., 25: 625-31(Winter 1967).

Using the direct chamber counting method of Pilot, the effect of irradiation on circulating eosinophils, was studied. It was found that 780 R and 1500 R irradiation to the whole-body or the body alone brought about an immediate (within three hours), marked, and sustained (to 72 hours) eosinopenia in rats. Animals receiving 780 R to the head alone exhibited only a momentary and slight eosinopenia. Rats receiving 1500 R to the head showed the same degree of eosinopenia as that observed in those animals irradiated whole-body with 1500 R. No recovery was noted in any of the rats exhibiting marked eosinopenia, even during the time periods in which decreases in adrenocorticoids were reported. The data indicated that the eosinophil response in x-irradiated rats cannot be fully explained on the basis of an increase in circulating ACTH or/and corticoids. (auth)

23632 HEMOPOIETIC COLONY STUDIES. V. EFFECT OF HEMOPOIETIC ORGAN STROMA ON DIFFERENTIATION OF PLURIPOTENT STEM CELLS. Wolf, N. S.; Trentin, J. J. (Baylor Univ., Houston, Tex.). J. Exp. Med., 127: 205-14(Jan. 1, 1968).

In heavily irradiated mice, bone marrow regeneration of either endogenous or exogenous origin was shown to occur in discrete foci comparable to the more intensively studied spleen colonies. The number of endogenous bone marrow colonies was inversely related to dose of whole-body x radiation. Endogenous marrow colonies were found after higher doses of irradiation than were endogenous spleen colonies. Most of them were granulocytic in nature. Exogenous bone marrow colonies in lethally irradiated mice injected with bone marrow cells were proportional in number to the dose of cells injected, appeared at a time comparable to spleen colonies like which, at seven or eight days, they were of single differentiated cell line, either granuloid or erythroid or megakaryocytic, with a small percentage of mixed colonies. Whereas erythroid colonies outnumber granuloid colonies in spleen, either in situ or subcutaneously transplanted (E : G colony ratio of about 3.5), granuloid colonies outnumber erythroid in bone marrow (E : G colony ratio of about 0.7). The characteristic E : G colony ratios of spleen and marrow appear more likely to be the result of a hemopoietic organ stromal influence on pluripotent colony forming units (CFU's) than of selective lodgment of committed (unipotent) granuloid and erythroid CFU's in bone marrow and spleen, respectively, as indicated by the following. Bone marrow stem cells (CFU) that had reseeded the marrow cavity of irradiated primary recipients 18 to 24 hr earlier, were reharvested and retransplanted intravenously into irradiated secondary hosts. The

E : G colony ratio of the colonies formed in the spleen of the secondary hosts was typical of primary spleen colonies (2.8), that of the colonies formed in the marrow cavity was typical of bone marrow colonies (0.6). Pieces of marrow stroma containing reseeded CFU's from the contralateral femur of these same primary recipients were implanted by trocar directly into the spleens of other irradiated secondary recipients. Those CFU's that developed in the intrasplenic-implanted marrow stroma yielded an E : G colony ratio of 0.1. Those that migrated into the contiguous and remote portions of the spleen gave E : G colony ratios of 2.9 and 2.4, respectively. Irradiated marrow stroma and normal spleen CFU's (a 1 mm cube of spleen) were loaded into the same trocar and implanted directly into the spleens of irradiated mice. The spleen CFU's that migrated into the implanted marrow stroma yielded five granuloid and two mixed colonies. The larger number that developed in the host spleen yielded an E : G colony ratio of 2.9 or higher. Of those 19 mixed colonies that bridged the junction of spleen and implanted marrow stroma in each of the above two experiments, in every case, the erythroid portion of the colony was in the splenic stroma, the granuloid portion was in the marrow stroma. (auth)

23633 REPLICATION OF TYPE C VIRUS PARTICLES IN THYMUS GRAFTS OF C57BL MICE INOCULATED WITH RADIATION LEUKEMIA VIRUS. Carnes, William H.; Lieberman, Miriam; Marchildon, Michael; Kaplan, Henry S. (Univ. of Utah, Salt Lake City. Stanford Univ., Palo Alto, Calif.). Cancer Res., 28: 98-103(Jan. 1968).

Electron microscopy demonstrated the replication of virus particles in considerable quantity in intrarenal thymus grafts in irradiated C57BL/Ka mice during the latent period of lymphoma induction by cell-free extracts of lymphomas similarly induced. The incidence of tumors was high and the latent period was short. The particles could not be found in similarly prepared control mice inoculated with saline and those mice did not develop lymphomas. Only one lymphoma developed in similar controls inoculated with heated cell-free extract, and no virus was found in those grafts. It is concluded that the lymphomagenic activity of cell-free extracts of radiation-induced lymphomas of C57BL mice is associated with a virus resembling other murine leukemia viruses. Reasons are quoted for regarding it as a distinct member of this group. The observations indicate that the virus replicates rapidly in regenerating thymus grafts. (auth)

23634 INFLUENCE OF IRRADIATION AND CORTISONE ON THE SPREAD OF EHRLICH'S CARCINOMA AND ON THEIR RATE OF GROWTH IN THE LUNGS AND LIVER OF MICE. Berkovich, M. L.; Chernukh, A. M. (Inst. of Normal and Pathological Physiology, Moscow). Byull. Eksp. Biol. Med., 64: No. 7, 89-93(July 1967). (In Russian).

Treatment of mice with x irradiation or cortisone 2 days prior to intravenous inoculation of suspension of tumor cells increased the rate of growth and frequency and intensity of metastases of internal organs. Data, obtained by analysis of kinetics of metastatic growth in the lung and liver of these animals, as compared to control, indicated an increase of adhesive properties of the endothelium of lung capillaries. The rate of metastatic growth in this organ in x-irradiated and cortisone-treated animals was 3.5 times greater than in the control group. Liver metastases were larger and grew more rapidly than those in the liver of controls. (auth)

23635 USE OF AN IMAGE CONVERTER M-9 FOR VISUAL STUDY IN ULTRAVIOLET MICROSCOPE OF THE ACTION OF ULTRAVIOLET RAYS ON CELLS OF TISSUE CULTURES. Korn, M. Ya.; Butslov, M. M.; Chakhava, O. V.; Solov'ev, N. N. (Gamaleia Inst. of Epidemiology and Microbiology, Moscow). Byull. Eksp. Biol. Med., 64: No. 7, 118-20(July 1967). (In Russian).

The action of ultraviolet irradiation on tissue culture cells was studied using an ultraviolet microscope with an image converter with magnetic focussing. The image converter permitted direct observation on a fluorescent screen with a diameter of 45 mm a clearcut image of cell structure and changes taking place after irradiation. Advantages of the use of image converter with magnetic focussing as compared with other methods of transformation of an invisible ultraviolet image into a visible one are shown. It was found that after ultraviolet irradiation during further cultivation of cells the volume of nuclei decreased. The dimensions and form of cells and the transparency of cytoplasm were also modified. (auth)

23636 CELL PROLIFERATION IN THE REGENERATING LIVER OF CONTINUOUSLY IRRADIATED MICE. Fabrikant, Jacob I. (Inst. of Cancer Research, Sutton, Eng.). Brit. J. Radiol., 40: 487-95(July 1967).

The effect of prior continuous irradiation at dose-rates of from 16 to 70 rads per day for up to 100 days on the regenerative capacity of the liver was examined in young C57BL mice after partial hepatectomy in order to investigate the extent to which a slowly proliferating cell renewal system accumulates, stores and repairs lethal and non-lethal latent cellular radiation injury affecting the pattern of cell proliferation and thus the speed and efficiency of regeneration. Radiation effects on DNA synthesis and cell division were determined by analysis of incorporation of labeled DNA precursor (tritiated thymidine) and changes in mitotic indices in autoradiographic preparations. Comparison of changes in liver weight, labeling and mitotic indices and nuclear grain counts revealed that prior continuous exposure delayed the appearance of peak activity of proliferation of the parenchymal and littoral cell populations for periods up to 24 hours. This inhibition was dependent on dose-rate, duration of exposure and accumulated dose. At the higher dose-rates and after long periods of irradiation there were a decrease in the rate of entry of cells into synthesis and mitosis, a decrease in the number of hepatocytes taking part in the regenerative process, an increase in the overall duration of cell proliferation during regeneration, and increase in the number of observable chromosome aberrations and possibly of polyploid parenchymal cells. In spite of relatively large accumulated radiation doses, cell proliferation was initiated and maintained to restore most of the liver mass during the period of observation, particularly at the lower dose-rates. (auth)

23637 CELL SURVIVAL AND RADIATION DAMAGE IN GROWTH CARTILAGE. Kember, N. F. (Royal Free Hospital, London). Brit. J. Radiol., 40: 496-505(July 1967).

The development of recovery clones in radiation injured growth cartilage is described and the significance of late degeneration of clones is related to the cell-survival system based on clone counting. Cell-survival data are presented for irradiations of the cartilage plate in rat tibiae: animals breathing air, $D_0 \sim 165$ rads, $n \sim 6$; anoxia, $D_0 \sim 340$ rads, $n \sim 20$; animals breathing oxygen at three atmospheres, $D_0 \sim 145$ rads; oxygen at one atmosphere, $D_0 \sim 150$ rads 95 per cent oxygen and 5 per cent CO_2, $D_0 \sim 150$ rads. The variation in recovery ratio with interval between two fractionated doses is described and an unsuccessful attempt made to relate these variations to changes in mitotic index. The results are compared with survival data from other mammalian cell systems. (auth)

23638 RISK OF BONE CANCER IN MAN FROM INTERNALLY DEPOSITED RADIUM. Hems, G. (Radiological Protection Service, Sutton, Eng.). Brit. J. Radiol., 40: 506-11(July 1967).

From an analysis of data on persons exposed in the United States to radium it is estimated that 100 μCi introduced into the bloodstream over a period of a few months or years would lead to an incidence of one bone tumor per 20 persons exposed. The tumors would be expected to appear 15 to 30 years after exposure. The main source of uncertainty in this risk estimate is the possibility of bias in the United States cases. However, the risk estimate is consistent with the absence of tumors in the British luminisers, a group that is known to be free from bias. For full occupational exposure to radium during a 50 year working life the risk of induction of a tumor is estimated to be about one per 1,200 persons exposed. This value was derived on the assumption that the tumor incidence would be the same as for a single intake of the same total amount of radium. It is likely to be an overestimate. (auth)

23639 STUDIES ON RIFT VALLEY FEVER VIRUS INFECTION. 3. EFFECT OF X RAY RADIATION AND CORTISONE TREATMENT ON RIFT VALLEY FEVER VIRUS INFECTION IN MICE. Sagae, Kazuko (Hokkaido Inst. of Public Health, Japan). Hokkaidoritsu Eisei Kenkyushoho, No. 17, 169-71(June 1967). (In Japanese).

The infectivity of the Rift Valley Fever virus for x-irradiated and/or cortisone-treated mice was investigated. The mice were irradiated and/or injected 24 hour prior to inoculation of the virus. It was observed that the infectivity of the virus was enhanced by the radiation and/or cortisone treatment; however, the infectivity was not increased synergistically. The enhancing effects were not synergistic even when the virus was inoculated into the pretreated mice in a virus-yolk mixture form. (TSS) (NSA of Japan)

23640 REGENERATION OF PERIPHERAL BLOOD IN THE THYMECTOMIZED MICE AFTER SUBLETHAL WHOLE-BODY IRRADIATION. Schneiberg, K.; Stiller-Winkler, R.; Jonecko, A. Pol. Med. J., 6: 1163-79(1967).

Translated from Postepy Hig. Med. Dosw., 20: No. 6, (1966).

Thymectomy was performed in mice of both sexes of two inbred strains, BA and C_{57} black, in a group of immature animals 3 weeks old, and in a group of adult animals 3 months of age. One month later the animals were irradiated with a single dose of 500 R of x rays. Mortality was scrutinized during a period of 90 days and peripheral blood was periodically examined. Immature thymectomized mice exhibit an increased mortality 67.5%,

as compared to 31.5% in control animals. Thymectomy in adult animals did not impair the natural resistance to ionizing radiation. In all animals that died, regeneration of granulocytes was insufficient. Among the animals surviving 90 days after irradiation, the thymectomized group exhibited distinct lymphopenia. Thus, the thymus was found to be an important organ of lymphocytopoiesis throughout the whole life of the mouse, moreover, it seems to be indispensable for granulocytopoiesis in the young animals. The latter role of thymus disappears later in life. This hematopoietic function of the organ persisted longer in mice born in winter or spring. (auth)

23641 DAILY FLUCTUATIONS OF THE RADIOSENSITIVITY OF MICE. Darenskaya, N. G.; Kuznetsova, S. S. (Inst. of Biophysics, Moscow). Radiobiologiya, 7: 891-2(1967). (In Russian).

White mice of both sexes, weighing 22 to 26 g, received doses of 174 to 196 R/min in two experiments and 709 R/min in a third from a ^{60}Co source in a uniform γ field. Individual groups received one dose a day at 0900, 1200, 1500, 1800, 2100, 0300 and 0600 hours. In the first two experiments, doses of 580 R produced mortalities of 41.9 and 51.2%, respectively. In the third experiment, the animals received doses of 500, 600, 700 and 800 R and the $LD_{50/30}$ was determined for each time of day. In all three experiments the groups irradiated at 0900 to 1200 and 2400 hours had the largest mortality; a similar daily rhythm of radiosensitivity for the other mice was also observed. (JPRS)

23642 HERPES ZOSTER FOLLOWING RADIATION THERAPY. THE RESULTS OF ENQUETE. Kobayashi, Toshio; Kiyono, Kunihiko (Shinshu Univ., Japan). Nippon Igaku Hoshasen Gakkai Zasshi, 27: 1083-7(Nov. 1967). (In Japanese).

The occurrence of Herpes zoster infections in patients following radiotherapy of primary malignant lesions was investigated. Two hundred and ninety-seven cases were found and the cause of the occurrence of Herpes zoster is briefly discussed. It was concluded that the occurrence of Herpes zoster in patients following radiotherapy may be an important complication that is due to the depression of the patient's immunity and/or resistance. (TSS) (NSA of Japan)

23643 RADIATION BREEDING OF THE DOMESTIC FOWLS. I. THE EFFECTS OF LONG TIME IRRADIATION WITH GAMMA RAYS (^{60}Co) ON CHICK GROWTH, EGG PRODUCTION, AND FERTILITY. Kashiwabara, Takao; Tanaka, Ryoichi (Ibaraki Univ., Japan). Ibaraki Daigaku Nogakubu Gakujutsu Hokoku, No. 14, 25-33(Oct. 1966). (In Japanese).

Four-month-old chickens were kept from July 1 to September 29, 1965, in cage batteries that received total doses of 500, 1,000, and 1,500 R from a ^{60}Co source. In chickens γ-irradiated at any dose, the growth rates of White Leghorn (WL) and New Hampshire (NH) females increased and that of males was delayed. No deaths were observed during these exposures. Sexual maturity was delayed in every irradiated group. However, no decline in the persistence of egg laying, rate of production, and egg weight was observed ninety-two or two hundred fifty-seven days after irradiation. Male chickens irradiated with 500 to 1,500 R showed a sharply decreased overall sperm production and fertility. Fertility level was improved after replacement of irradiated males by normal control males. In general, cockerels were more radiosensitive than pullets during the three months of γ-irradiation at dose rates of 16.3 R/day. Female germ cells and reproductive organs showed radioresistance. (NSA of Japan)

23644 CULTIVATION IN TISSUE CULTURE OF LEUKEMIC CELLS FROM MOUSE LEUKEMIA INDUCED BY X RAYS. Rokutanda, Makoto (Kyoto Univ.). Nippon Ketsueki Gakkai Zasshi, 29: 985-95(Dec. 1966). (In Japanese).

The leukemic cells, induced by x radiation in S(SMA) mice of low-leukemic strain, were cultured in vitro and the properties of these cells were virologically and histologically studied. Thymic lymphoma was induced in four of the 11 S-mice irradiated by x rays. The average latent period from x ray irradiation to the occurrence of tumor was 284 days. The cultured leukemic cells grew well in stationary and agitation cultures. Their generation time in the stationary culture was 14.5 hours, and their doubling time in the agitation culture was about 19.5 hours. The cultured leukemic cells were 10 to 15 μ in diameter and most of them had one nucleus. The number of their chromosomes was a normal distribution with 40 as the middle. Most of them were of the diploid type. Despite the prolonged cultivation, the cultured cells retained the character of malignant lymphatic cells of S-mice. It was impossible to transplant these cells to mice other than S-mice. The cultured cells produced a large number of C type particles on the cytoplasmic membrane and contained A-type particles in the cytoplasm. (NSA of Japan)

23645 HETEROZYGOUS CHROMOSOMAL ABERRATIONS IN THE VIABLE OFFSPRING OF X-IRRADIATED MALE NEWTS (PLEURODELES WALTLII MICHAH). Jaylet, A.; Bacquier, Colette (Faculte des Sciences, Toulouse). Cytogenetics, 6: 390-401(1967). (In French).

The offspring of irradiated male newts was studied with a view to finding chromosomal aberrations. Several male newts (Pleurodeles waltlii) were given from 250 to 500 R x rays to the hind part of the body and immediately placed with an unirradiated female. The proportion of abnormal embryos obtained from these matings was very significant. It was decided to investigate the viable offspring of irradiated males and to determine the types of chromosomal aberrations that they carried. The first results obtained on 80 viable metamorphosed animals are described. Six animals with chromosome aberrations were studied in detail. They had translocations and deletions. (auth)

23646 DEVELOPMENT OF RADIATION INJURIES. Schreiber, P. Militartechnik, No. 3, 111-13(1967). (In German).

That internal organs vary in their sensitivity to radiation and that a distinction must be made between radiosensitive and radioresistant organs is emphasized. Several somatic and genetic cases of importance are discussed briefly; injuries to the skin, blood forming tissues, intestinal mucous membrane, and antibodies. The general state of health, leukemia, and biologic mutations are also considered. A formula is presented for use in calculating the effective half-time period for the eliminating of isotopes from the body. (auth) (ATD)

23647 LATE TUMOURS AFTER RADIOLOGICAL TREATMENT OF GYNECOLOGIC MALIGNOMAS. A CLINICAL STUDY OF POSTACTINIC CHANGES WITH SPECIAL REFERENCE TO THE DEVELOPMENT OF SO-CALLED RADIOGENIC TUMOUR. Holan, J. (University Hospital, Martin, Czechoslovakia). Neoplasma, 14: 399-424(1967).

The possibility of the tumor development in tissue injured by radiation in which long-term regeneration processes take place is well known both in experiment and in clinic. It occurs also after past radiation therapy of gynecologic lesions irrespective of originally benign or malignant disease. Postradiation changes were followed up in women with 6 to 25-year survival after the treatment. The occurrence of heavy chronic cicatrization, precancerous lesions and actual tumors is referred to. The chief signs of tumors of radiogenic origin were as follows: a) localization in the adjacent tissue which is still in the area of biological action of radiation, b) histologic pattern which differs substantially from that of original malignant tumor and has characteristic feature of the considered adjacent tissue, c) enhancing promoting factors (chronic inflammation and regeneration processes, new irradiation, mechanic injuries), d) long-term period free of clinical symptoms (16.4 years on average). (auth)

23648 EFFECT OF VARIOUS FRACTIONATION REGIMES ON THE RADIATION RESPONSE OF TUMOR CELLS. Siracka, E.; Siracky, J. (Cancer Research Inst., Bratislava). Neoplasma, 14: 425-8(1967).

Four types of fractionation regimes were used for the irradiation of Walker tumor. The interval between fractionated treatments increased with the increasing size of treatment doses. The suspension from the irradiated tumors was then transplanted to healthy rats 24, 48 hours and 1 week after the termination of the radiation. The treatment with fewer and larger doses showed more favorable radiation response than the regime with smaller and frequent radiation treatments. The transplantation of irradiated tumors exhibited the lowest percentage of tumor takes when carried out 48 hours after the completion of irradiation. (auth)

23649 NEW HAZARD DUE TO HIGH-FREQUENCY ELECTROMAGNETIC FIELDS. Sankiewicz, M.; Budzynski, G. Ochr. Pr., 22: No. 3, 12-15(Mar. 1967). (In Polish).

The operator of a heavy crane at the naval dockyards in Szczecin (Poland) sustained slight burns due to currents induced by transmissions from a broadcasting station two miles away. The cause of the accident is identified as high-frequency currents induced by the electromagnetic field from a radio transmitting station in the medium wave band. In the light of this case, the authors review the potential hazards of exposure to x rays and to very high frequency, ultra-high frequency and micrometric radio waves, and recommend that research on induction phenomena involving high-frequency potentials should be pursued. (Occup. Safety and Health Abstr.)

23650 VOPROSY OBSHCHEI RADIOBIOLOGII. (Problems of General Radiobiology). Domshlak, M. P. (ed.). Moscow, Atomizdat, 1966. 304p.

Separate abstracts were prepared for 27 papers of the book.

Topics included the radiosensitivity of various animals, effects of radiation on their behavior, and problems of dosimetry and RBE. (F.M.M.)

For abstracts of individual papers see: 23429–23431, 23529, 23530, 23650–23671, and 23685.

23651 EXPERIMENTAL EVALUATION OF THE SIGNIFICANCE OF THE DOSE RATE FOR BIOLOGICAL EFFECTIVENESS OF INCORPORATED RADIOACTIVE ISOTOPES: METHOD OF SIMULATING INTERNAL IRRADIATION WITH EXTERNAL IRRADIATION ACCORDING TO TIME DISTRIBUTION. Avrunina, G. A. pp 53-62 of Voprosy Obshchei Radiobiologii. Domshlak, M. P. (ed.). Moscow, Atomizdat, 1966. (In Russian).

The difficulties of determining the RBE of an internal irradiation dose were discussed and a method was proposed to simplify the problem. The method was based on the use of external irradiation as a model to simulate internal irradiation in comparing RBE. The spatial distribution of an internal irradiation dose was practically impossible to reproduce in a model, but time distribution could be simulated by determining the time distribution of an internal emitter dose. The selection of a time interval (hourly, daily, weekly or other) for averaging the dose rate of an internal emitter depended on the half life of the isotope and its excretion rate from the body. With dosimetry of internal irradiation based primarily on measurement of absolute activity, the problem was reduced to studying the dynamics of the activity level in experimental animals and computing the dose rate according to formula. A given internal irradiation effect could be simulated with external irradiation by using one or a combination of the averaged dose rates. As long as the simulated irradiation had to be constant, x radiation could not be used; however, γ radiation was suitable for such purposes. At the time of simulated irradiation, animals should be placed under similar conditions as in actual experiments with internal administration of isotopes. In a series of experiments staged on rats using averaged dose rates of radiophosphorus, the effectiveness of internal and external irradiation was the same, and in some cases slightly higher for internal irradiation. On the whole, it appeared that the spatial distribution of an internal emitter dose quantitatively did not play as significant a role as was often assumed. (ATD)

23652 MODEL INVESTIGATIONS OF COSMIC RADIATION BIOLOGIC EFFECT. Lebedinskii, A. V.; Nefedov, Yu. G.; Domshlak, M. P.; (and others). pp 242-54 of Voprosy Obshchei Radiobiologii. Domshlak, M. P. (ed.). Moscow, Atomizdat, 1966. (In Russian).

With space flights of longer duration, cosmic rays, radiation belts and solar flares present an increasing danger to astronauts. However, relatively little is known of the biologic effect of cosmic radiation and its components, particularly high energy protons. In the present study the RBE of high energy protons was compared in large laboratory animals (dogs) and small laboratory animals (rats) to determine possible RBE differences. In a series of experiments groups of dogs were irradiated with high energy protons and x radiation (or gamma radiation) in fractional and single doses of 250 to 650 rads; groups of rats (Wistar line) were also irradiated with fractional and single doses of 300 to 1200 rads. A synchrocyclotron was used for proton irradiation (510 MeV, field diameter 40 cm, dose rate of 1 rad/sec). Clinical symptoms, histological investigations, EEG data, mean survival periods, and post mortem examinations served as indices. Results showed that with fractional dose irradiation of dogs, the RBE of proton irradiation (510 MeV) and x radiation (180 kV) was the same (1.0). With fractional irradiation of rats, the RBE of proton irradiation was 0.8. With single dose irradiation of dogs, the RBE of protons was 1.15 compared to gamma irradiation. With single dose irradiation of rats, the RBE of protons was 0.75 compared to gamma irradiation. No conclusions were drawn. (ATD)

23653 DISTURBANCES IN METABOLISM OF NUCLEIC COMPOUNDS IN RATS UNDER PROLONGED γ IRRADIATION. Zharkov, Yu. A.; Tereshchenko, O. Ya.; Koznova, L. B.; Mikhailova, L. F. pp 277-81 of Voprosy Obshchei Radiobiologii. Domshlak, M. P. (ed.). Moscow, Atomizdat, 1966. (In Russian).

A survey of the literature on the disturbances in metabolism of nucleic compounds in rats under prolonged γ irradiation was presented. (JPRS)

23654 BEHAVIOR OF WHITE RATS, GUINEA PIGS, AND MONKEYS IN A FIELD OF γ RADIATION. Darenskaya, N. G.; Pravdina, G. M.; Khrushchev, V. G. pp 90-7 of Voprosy Obshchei Radiobiologii. Domshlak, M. P. (ed.). Moscow, Atomizdat, 1966. (In Russian).

Experiments were conducted to determine the ability of white rats, guinea pigs, and monkeys to detect the location of a source of radiation and to avoid it. With two bowls of water available, bowl A being in and bowl B being out of a γ field of four sources with a total activity of 246 mg-equiv Ra, rats drank 1.5 to 3.5 times as much from bowl B and continued to avoid bowl A for 20 days after the radiation sources were removed. Under the same conditions, guinea pigs drank 3 to 10 times as much from bowl B and also continued avoidance. Monkeys also reacted to the γ radiation by reducing the consumption of liquid from bowl A but the consumption from the two bowls was equalized at once after the source of radiation was removed. The monkeys reacted to smaller dose rates (0.008 R/sec) than mice (0.35 to 0.45 R/sec) in experiments previously reported. (JPRS)

23655 MORPHOLOGICAL CHANGES OF THE INTESTINE IN ACUTE RADIATION SICKNESS FROM EXTERNAL IRRADIATION. Lebedeva, G. A. pp 195-201 of Voprosy Obshchei Radiobiologii. Domshlak, M. P. (ed.). Moscow, Atomizdat, 1966. (In Russian).

A survey of the literature on the morphological changes of the intestine in acute radiation sickness from external irradiation is presented. (JPRS)

23656 SOME DATA ON THE SIGNIFICANCE OF FREQUENCY AND TOTAL EXPOSURE TIME IN THE BIOLOGICAL EFFECT OF PULSED RADIATION. Skuratovich, A. A. pp 294-302 of Voprosy Obshchei Radiobiologii. Domshlak, M. P. (ed.). Moscow, Atomizdat, 1966. (In Russian).

The biological effect of various parameters of ultrafractionated radiation was studied on 320 Wistar strain male white rats weighing 180 to 220 g. A four-tube x-ray apparatus with a wide power range (0.1 to 20 mamp in each tube) was used. Pulsed radiation was obtained with ion switches. Pulse duration was 0.02 sec (corresponding to 50 cycle a-c); power was on for every 4th, 16th, or 64th cycle. The pulse interval was thus 0.06, 0.3, or 1.26 sec, pulse frequency was 750, 198, and 46.8 per min, and the pulse dose was 1.5 R. Exposure time varied from 27 sec to 7.5 min. Controls were irradiated with continuous doses equal to the total pulsed doses in each series. Indices studied included leukocyte counts, weight dynamics, 24-hr bone marrow mitotic indices, and mortality. Following 250 R, weight gain was slower and the drop in mitotic activity more rapid in the group irradiated with pulses every 4th cycle. However, observed differences between the biological effect of 450 R given every 64th cycle (9.5% mortality) with that of 450 R given continuously at 1 to 1.3 R/sec (33.3% mortality) could not be due to exposure time, since these were similar, and must be attributed to the difference in exposure conditions. At higher doses (675 R), this difference disappeared. The biological effect of repeated irradiation with a sublethal dose (250 R) also varied depending on whether irradiation was pulsed or continuous. It was possible that these differences were due to different effects of pulsed and continuous primary irradiation on the immunological and hormonal state of the organism. (ATD)

23657 GENERAL RADIOSENSITIVITY PROBLEMS OF AN ORGANISM. Gorizontov, P. D.; Darenskaya, N. G.; Domshlak, M. P.; Tsypin, A. B. pp 63-89 of Voprosy Obshchei Radiobiologii. Domshlak, M. P. (ed.). Moscow, Atomizdat, 1966. (In Russian).

A survey was made of various aspects of radiosensitivity differences related to animal species, strain or line, age, sex, time of year and individual radiosensitivity. Of these the latter was most complex and varied most widely. Individual radiosensitivity depended primarily on the functional state of the central nervous system, body metabolism, endocrine system, blood and other systems. Study data demonstrated a high correlation between radiosensitivity of an organism and its general state of reactivity at the time of irradiation. Animals displaying resistance to various harmful factors and physical strain by well expressed adaptive responses of the cardiovascular, respiratory, and nervous systems were generally also more radioresistant. The outlook for changing radiosensitivity by finding ways to influence the reactivity of an organism appeared promising. (ATD)

23658 RELATIONSHIP BETWEEN RADIOSENSITIVITY AND RADIORESISTANCE OF THE NERVOUS SYSTEM. Tsypin, A. B. pp 103-17 of Voprosy Obshchei Radiobiologii. Domshlak, M. P. (ed.). Moscow, Atomizdat, 1966. (In Russian).

Experiments were undertaken to demonstrate the difference between radioresistivity and radioresistance and to discover in what ways they were related. The relation between radiosensitivity of the organism and the radioresistance of the nervous system was studied in 35 male Chinchilla rabbits (2.5 to 3 kg). Nervous system radiosensitivity was determined by brain biocurrent reactions during γ irradiation of either the head (series one: 20 rabbits; 1.3 R/sec) or the thorax (series two: 15 rabbits; 0.13 R/sec) for 5 min. It was found that the animals with the greater radiosensitivity (reactivity), in which a biocurrent reaction commenced within the first 100 sec of irradiation, had a much higher resistance (mortality 31.5%) than those in which the reaction

appeared after 100 sec or not at all during irradiation. This was true of both series (head alone or thorax alone), though biocurrent reactions to irradiation were more clearly marked in series two (the thorax group). It should be noted that excessive reactivity apparently indicated the operation of some unfavorable factor, since five out of eight rabbits reacting very early during irradiation (within the first 13 sec) succumbed. It seemed true that prompt biocurrent reactions signalled the triggering of protective and compensatory mechanisms which increased radioresistance, and the absence of prompt biocurrent reactions indicated the failure of these protective mechanisms to come into play. Experiments were conducted on 80 frogs to compare the radiosensitivity (reactivity) of the retina to γ radiation from a short-focus OKFO-1 ^{60}Co source with retinal radioresistance (resistance to injury). The criterion of reactivity was the immediate ERG (electroretinogram) reaction (increased activity during γ irradiation). The criterion of damage decreased reactivity (also ERG) to adequate light stimulation. Most frog retinas reacted to a γ-ray dose rate of 0.015 R/sec. The latent period of the reaction was about 0.45 sec, giving a total dose at the moment of the reaction of about 0.007 R. The most sensitive specimens reacted to γ-ray stimulation at a rate of 0.001 R/sec. The retina was thus seen to be highly sensitive (reactive) to ionizing radiation. These dose levels did not cause any radiation damage: determinations of the functional state of the retina (reactivity to adequate light stimulus) before and after irradiation showed no change. Much larger doses (1000 R or more) were required to cause radiation damage (decreased reactivity to light stimulation) in most cases. The difference in γ-ray dose levels stimulating ERG activity and those causing damage was six or seven orders of magnitude. The activity of the lymphatic heart in frogs during γ irradiation at 5 R/sec showed this organ to be highly reactive to radiation. A total dose of 5 to 10 R usually produced changes in the amplitude of contraction. At the same time, the dose required to suppress heart action was very high (of the order of 10,000 to 100,000 R). This experiment likewise indicated that there was little relation between radiosensitivity and radioresistance. Small doses (10 R) of radiation affected the CNS much as any other adequate stimulus. The CNS could react to radiation dose rates of the order of 10^{-2} and 10^{-1} R/sec; normal background radiation was of the order of 0.0005 R/24 hr. The threshold of reactivity was thus seven or eight orders of magnitude above the background value. It was concluded that radiosensitivity and radioresistance were not only not identical, but reflected entirely different aspects of the effect of radiation on the CNS. (ATD)

23659 COMPARATIVE RADIOSENSITIVITY OF WISTAR AND UNPEDIGREED RATS. Darenskaya, N. G.; Pravdina, G. M. pp 126-34 of Voprosy Obshchei Radiobiologii. Domshlak, M. P. (ed.). Moscow, Atomizdat, 1966. (In Russian).

Wistar and unpedigreed rats in groups weighing 180 to 225 and 230 to 300 g underwent single whole-body irradiation at doses of 200, 300, 400, 500, 550, 600, 650, 700, 750, 800, 850, and 900 R at 630 to 337 R/min. The Wistar rats were more radiosensitive, having a $LD_{100/30}$ of 700 R as compared with 800 R in the unpedigreed and a $LD_{50/30}$ of 443 R as compared with 599 R. There was no essential difference in life span after irradiation at doses below 500 R. A well-expressed clinical picture of severe radiation sickness appeared on the second or third day in the Wistar rats and on the third or fourth day in the unpedigreed rats. Wistar rats that received 800 R exhibited well-defined nervous disorders (tremor of the head and extremities in 15%, spastic twitching of various groups of muscles in 50%, spasms of the extremities in 25%, spasms of the trunk muscles in 10%, and disorder in motion coordination in 8%) not manifested in the unpedigreed even after receiving 900 R. (JPRS)

23660 STATE OF THE CARDIOVASCULAR SYSTEM OF ANIMALS IN VERY SEVERE RADIATION SICKNESS. Sedov, V. V.; Nevskaya, G. F.; Borel'chik, K. I.; Kotova, E. S.; Grozdov, S. P. pp 180-95 of Voprosy Obshchei Radiobiologii. Domshlak, M. P. (ed.). Moscow, Atomizdat, 1966. (In Russian).

The state of the cardiovascular system was studied in 26 rabbits irradiated at doses of 2000 and 4000 R. The investigations were started immediately after irradiation and were continued until death. They included determination of the maximum arterial pressure in the common carotid artery brought out to a skin flap, electrocardiography, roentgenoangiography, measurement of the pulse wave velocity and investigation of the vessels of the eye. Very severe radiation sickness was characterized by marked insufficiency of blood circulation connected with circulatory disorders caused by changes of the function of the peripheral system and disturbances of cardiac activity. The changes developed simultaneously and produced an especially severe picture of cardiovascular insufficiency. (JPRS)

23661 COMPARATIVE RADIOSENSITIVITY OF C57 MICE AND UNPEDIGREED WHITE MICE RECEIVING DIFFERENT FOOD RATIONS. Darenskaya, N. G. pp 117-22 of Voprosy Obshchei Radiobiologii. Domshlak, M. P. (ed.). Moscow, Atomizdat, 1966. (In Russian).

Unpedigreed white mice and C57 black mice weighing 18 to 22 g received doses of 400, 500, 600, 700, 900, and 900 R at 376-364 R/min. When fed an ordinary ration they were found to have identical radiosensitivity as measured by mortality but different life spans according to the dose received. The C57 mice were more resistant to LD_{50} to LD_{70} doses and more sensitive to larger doses. When fed a special ration the $LD_{100/30}$ increased from 700 to 900 R for the white mice and decreased from 700 to 600 R for the black mice, thus manifesting a large intraspecies difference in radiosensitivity. (JPRS)

23662 COMPARATIVE RADIOSENSITIVITY OF MICE OF DIFFERENT INBRED LINES. Petrov, R. V.; Golovistikov, I. N.; Zhabina, M. I. pp 123-5 of Voprosy Obshchei Radiobiologii. Domshlak, M. P. (ed.). Moscow, Atomizdat, 1966. (In Russian).

Mice of lines C57BL/6, C3H/He and CBA 12 to 13 weeks old and weighing 22 to 24 g were simultaneously irradiated with doses of 500, 550, 600, 650, 700, 750, 800 and 850 R at 216 to 209 R/min. The C57BL/6 mice were the most radiosensitive ($LD_{50/30}$ = 585 ± 13 R, $LD_{99/30}$ = 745 R); the CBA mice were most radioresistant ($LD_{50/30}$ = 660 ± 13 R, $LD_{99/30}$ = 825 R), and the C3H/He mice occupied a middle position ($LD_{50/30}$ = 625 ± 17 R, $LD_{99/30}$ = 790 R). The differences were statistically significant and could be explained by genetic differences connected with increased damage to the intestine of C57BL/6 mice and the significance of a gastrointestinal syndrome in the radiation pathology of mice of that line. In C3H/H3 and CBA mice the principal mechanism of postirradiation death at the given doses involved the bone marrow. (JPRS)

23663 BEHAVIOR OF FISH IN A RADIATION ZONE. Pravdina, G. M. pp 97-103 of Voprosy Obshchei Radiobiologii. Domshlak, M. P. (ed.). Moscow, Atomizdat, 1966. (In Russian).

Experiments were conducted to determine whether Cyprinus carpio (carp) 1 to 1.5 years old could detect the presence of ^{60}Co and ^{137}Cs γ radiation with a total activity of 108 mg-equiv Ra and avoid it. After five weeks of control measurements the sources were installed in an access labyrinth for 17 days during which the fishes consumed 1.5 to seven times as much food in an area reached by a different path. The dosage rate was 2.48 rads/min and the dose averaged 0.12 R. No attempt was made to determine the threshold of sensitivity of the carp. (JPRS)

23664 RADIOBIOLOGICAL SIGNIFICANCE OF THE TIME FACTOR IN A DOSE CURVE PLATEAU. Koznova, L. B.; Bobrovnikov, I. D. pp 265-73 of Voprosy Obshchei Radiobiologii. Domshlak, M. P. (ed.). Moscow, Atomizdat, 1966. (In Russian).

The effect of dose rate on length of survival and on the plateau of a dose-effect curve were investigated in a series of experiments White male mice weighing 18 to 24 g were γ irradiated at a dose range of 1500 to 72,000 R at dose rates of 1.014, 3.0, 8.7, 252, 1158 and 48,000 R/min. Indexes included clinical symptoms of disease, mean survival periods, and post mortem findings. A dose-effect plateau was shown with dose rates of 252, 1158 and 48,000 R/min. Increase of dose rate from 252 to 48,000 R/min contributed to growth of survival periods. A comparison of clinical disease symptoms for dose rates of 252, 1158 and 48,000 R/min did not disclose any significant differences. Marked symptoms of intestinal death were found with doses up to 19,000 R, and deaths due to central nervous system damage were found with higher doses. Duration of irradiation, the time factor, rather than the dose rate basically determined radiation damage within a dose rate range of 1.014 to 8.7 R/min. A mathematical analysis of the experimental data was given. ((ATD)

23665 CHARACTERISTICS OF FUNCTIONAL CHANGES IN EYE OF RABBITS IRRADIATED WITH VARIOUS DOSES (25 TO 4000 r). Kotova, E. S. pp 158-75 of Voprosy Obshchei Radiobiologii. Domshlak, M. P. (ed.). Moscow, Atomizdat, 1966. (In Russian).

Investigations were made to determine how radioinduced changes in retinal circulation were related to the radiation dose, severity of radiation sickness, and individual reactivity, as well as to attempt to distinguish between the early vascular reaction to radiation itself and later changes occurring during the course of radiation sickness. Half-grown chincilla rabbits weighing 2.5 to 3.5 kg were used. The experimental group (58 rabbits) was irradiated at a 25-R dose of x rays and/or 500-, 800-, 1000-, 2000-, or 4000-R doses of γ rays. Ophthalmological studies included direct examination of the side-lit eyeball, corneal sensitivity, and pupillary reaction; the state of the refracting me-

dia was determined with an electroophthalmoscope and PEO-58 visuscope. The fundus was examined directly, and intraocular pressure was determined by Maklakov's method (using a 10 g weight). Systolic and diastolic pressures in the central retinal artery (CRA) and the diameter of retinal vessels were determined. Total-body irradiation with 25 R of x rays (15 rabbits; 180 kv, 5.6 mamp, 0.5 mm Cu + 1 mm Al; focal distance, 60 cm; rate, 13.6 R/min for 1 min 60 sec [sic]) produced no immediate reactions. Mild leukopenia was seen on the first to third days, and mild leukocytosis from the fifth to 10th days. Thereafter leukocyte counts returned to normal. Shifts in hemoglobin and erythrocyte count were negligible. The only ophthalmological reaction seen was a slight temporary increase (2 to 6 mm Hg) in systolic pressure in the CRA (over the maximum, not the mean, control value), from four to 26 min after irradiation; this dropped to normal in one to six hr. Total-body γ irradiation with 500 R (nine rabbits; EGO-2 source; rate, 290 R/min for 1 min 43 sec) killed 44% within 2 hr 25 min to 35.5 days. All the animals which died developed serious clinical symptoms of radiation sickness. The surviving rabbits displayed milder symptoms. Results of ophthalmological examination revealed immediate (seven min to several hours) effects: moderate to severe conjunctival hyperemia, hemorrhage beneath the conjunctiva, and dilation of veins in the fundus. Later effects included cloudiness of the retina around the optic nerve and retinal hemorrhage. Two characteristic types of CRA diameter and blood pressure reactions to 500 R were seen. The surviving rabbits displayed a phased reaction: CRA diastolic pressure rising in the ninth to 65th min, and remaining elevated two to three hr; CRA diastolic pressure dropping toward normal; a second, smaller increase in CRA diastolic pressure on the second day, replaced by progressive CRA hypotonia; maximum hypotonia coincident with the most severe phase of radiation sickness. Normalization began with 18th to 20th day. In the rabbits which died, CRA diastolic pressure dropped immediately after irradiation instead of rising. Degree and rate of drop were inversely proportional to time to death. It was concluded that the immediate rise in CRA diastolic pressure was a manifestation of the protective-adaptive reaction of the organism. Total body γ irradiation with 800 R (eight rabbits of which three had previously [1.5 months] received 25 R of x rays) killed 88% within one to 41 days. All the animals which died developed severe radiation sickness. Ophthalmological changes were similar to those seen after irradiation with 500 R, but more pronounced. The phase changes noted in CRA diastolic pressure in the rabbits surviving 500 R were seen in extreme and accelerated form in the one surviving rabbit in this group, while the steady decrease in CRA diastolic pressure seen in the rabbits succumbing to 500 R were likewise exaggerated in the rabbits succumbing to 800 R. Total body γ irradiation with 1000 R produced changes in the ophthalmological picture similar to those noted above. Phase changes in CRA diastolic pressure were not so clear as in the preceding experiments, but a slight rise in pressure, returning to normal and followed by severe hypotonia, was seen in these animals. Total body γ irradiation with 2000 R and 4000 R, which killed all the animals within an average of 3.5 days, produced nearly identical changes in the ophthalmological picture. Retinal vascular reactions were different from those observed with smaller doses: phase changes were absent, the CRA diastolic pressure dropping steadily from the first minute after irradiation until it became too small to measure. Such massive doses of radiation apparently immediately inhibited the CNS and forestalled any protective reactions in the organism. It was concluded that ophthalmological changes were clearly dependent on the dose received and that changes in CRA diastolic pressure were especially reliable indices of the protective-adaptive reaction of the organism to mild radiation injuries (doses less than 1000 R). (ATD)

23666 ACUTE INTESTINAL RADIATION DEATH. ANALYSIS OF DATA ON THE PLATEAU OF THE DOSE-EFFECT CURVE. Nevskaya, G. F. pp 175-80 of Voprosy Obshchei Radiobiologii. Domshlak, M. P. (ed.). Moscow, Atomizdat, 1966. (In Russian).

Acute intestinal radiation death is presented. Data on the plateau of the dose-effect curve are analyzed. (JPRS)

23667 BIOLOGICAL EFFECT OF ULTRAFRACTIONATED IRRADIATION. Skuratovich, A. A.; Koznova, L. B. pp 281-94 of Voprosy Obshchei Radiobiologii. Domshlak, M. P. (ed.). Moscow, Atomizdat, 1966. (In Russian).

Literature studies of the biological effect of ultrafractionated irradiation on lower animals were reviewed and results were compared. Ultrafractionated radiation was defined as a series of radiation pulses (several microseconds or milliseconds in length) separated by intervals of up to a few seconds' duration. With this type of radiation, the dose rate could be affected by the pulse frequency, length of the pulse, and the relationship between pulse length and interval length. Investigations conducted in the last decade showed mostly that the biological effect of pulsed radiation was less than the effect of uninterrupted radiation. Wheat sprouts were irradiated with pulsed x-rays and uninterrupted x rays in doses of 500 and 1000 R. It was observed that 1000 R of pulsed x rays had a lesser biological effect than the same dose of uninterrupted x rays (10% judged by the length of roots 120 hr after moistening). Fruit fly eggs 4.5 hr old were irradiated with β rays from a radium source in doses of 400 to 800 R. Experiments showed that increasing the pulse frequency increased the damaging effect of the radiation. However, above a certain limit the biological effect decreased even though the pulse frequency increased further. Increasing the ratio of pulse to pause (for example from 1:4.7 to 1:2.25) shifted the maximum effect in the direction of higher frequencies. Increasing the dose (while retaining the same pulse-to-pause ratio) also shifted the maximum effect to higher frequencies. It was observed that the damaging effect of uninterrupted irradiation was greater than the biological effect of pulsed radiation. The variety of results obtained by different researchers was explained by the different biological objects used (rabbit skin, human skin, tumor tissue, Ascaris eggs, fruitfly eggs and wheat seeds), by the different irradiation parameters, and the different types of radiation (x rays and Ra rays). The following general conclusions were drawn after comparing results of all the experiments reviewed. The effect of pulse frequency on biological effect depended on the object. Pulse frequency did not influence the final biological effect with x irradiation; however, for certain biological objects the greatest damaging effect of β radiation appeared at a definite pulse frequency. In most cases, increasing the ratio of pulse to pause increased the biological effect. There was no generally accepted explanation for the observed difference between the biological effects of ultrafractionated and uninterrupted irradiation. (ATD)

23668 DOSE-EFFECT RELATIONSHIPS FOR 120-MeV PROTONS OBSERVED DURING LONG-TERM EXPERIMENTS. Petrovich, I. K.; Moskalev, Yu. I.; Strel'tsova, V. N. pp 202-14 of Voprosy Obshchei Radiobiologii. Domshlak, M. P. (ed.). Moscow, Atomizdat, 1966. (In Russian).

Experiments were conducted to determine the biological effect of 120-MeV protons. Ten groups of rats three to four months old were irradiated once with protons from the OIYaI synchrocyclotron at Dubna in doses of 10 to 1000 rad (dose rate 0.3 rad/sec). Animals were placed in revolving chambers to ensure uniformity of irradiation. The following criteria of the radiation effect were examined from the standpoint of long-term influence: dependence of length of life on radiation dose, blood composition, and the time of appearance, frequency of appearance, and character of tumors. Experimental results showed that the LD_{50} for rats dying within 30, 60, 120, and 240 days was practically identical. The death rate was equivalent in males and females for a given dose, except in the remote aftereffect period (480 and 600 days), when females were more radiosensitive due to neoplasms in mammary and other secretory glands. It was found that 120-MeV protons had the same RBE as 500-MeV protons, which was approximately 0.7 as compared with gamma rays. The average lengths of life of animals irradiated with various doses of 120-MeV protons were presented. The number of animals dying in a given period increased with increasing dose. However, the average length of life of rats dying in this period did not depend on the dose: for example, the average length of life of rats dying 16 to 30 days after irradiation with doses of 400, 600, 700, and 800 Rad was 23, 22, 22, and 23 days, respectively. Neutropenia and lymphocytopenia were noted in the early postradiation period, together with a considerable drop in erythrocyte content with doses from 700 to 1000 Rad. The highest incidence of tumor formation in irradiated animals was noted in the following organs and tissues: mammary glands, hematopoietic tissue, thyroid gland, adrenal glands, subcutaneous cellular tissue kidneys, bones, uterus, thymus, and prostate gland. A higher frequency of mammary-gland tumors was observed in females irradiated with 50 to 600 Rad of protons than in the controls. Furthermore, the total frequency of thyroid tumors in irradiated male and female rats (doses of 10 to 800 Rad) was found to be 9.8%, which was ten times higher than the control rate. Complete data were lacking to establish the relationship of dose to frequency of occurrence of tumors in all tissues. (ATD)

23669 PECULIARITIES OF CLINICAL MANIFESTATIONS OF RADIATION SICKNESS IN RHESUS MONKEYS DURING γ IRRADIATION. Volokhova, N. A.; Gubin, V. A.; Darenskaya, N. G.; Koznova, L. B.; Korchemkin, V. I.; Nevskaya, G. F.; Sedov, V. V. pp. 150-7 of Voprosy Obshchei Radiobiologii. Domshlak, M. P. (ed.). Moscow, Atomizdat, 1966. (In Russian).

A comprehensive clinical examination of gamma-irradiated monkeys was conducted, and the data were compared with results of similar examinations of dogs. Seventeen monkeys (Macaca

rhesus) of both sexes, weighing 2.0 to 4.0 kg, were subjected to gamma irradiation from an EGO-2 apparatus with a dose rate of 357 to 313 R/min. Prior to irradiation, all monkeys had been under clinical observation for two to three weeks. Eleven of the 14 monkeys irradiated with 300 R died (average duration of life 16.5 days), while two of the three monkeys irradiated with 350 R died (29.5 and 36.2 days after irradiation). Both groups of gamma-irradiated monkeys were considered together, since the clinical manifestations of radiation sickness were similar in both groups. Experimental data were compared with data from analogous dog experiments, using a 300-R dose of gamma rays, and no essential differences in the radiation effect were noted between the two species. However, the spread of life durations in monkeys (6.5 to 36.2 days) was wider than for dogs (11.5 to 18.5 days). The primary reaction to radiation was more pronounced and developed more rapidly in monkeys than in dogs. The primary radiation reaction was absent in two out of 17 monkeys, as compared with 18 out of 28 dogs. Furthermore, seven monkeys experienced severe primary radiation reactions, while none of the dogs did. In the first 10 to 11 days after irradiation, no essential differences were noted between the temperature reactions of monkeys and dogs. However, by the time of death dogs had elevated body temperatures (average 1.5C above normal), whereas monkeys' temperatures had fallen considerably below normal. Symptoms of radiation sickness appeared later (15 to 18 days after irradiation) and developed more gradually in monkeys than in dogs (7 to 12 days). Autonomic dysfunction was considered responsible for the lability of symptoms in monkeys in the early postradiation period. This hypothesis was substantiated by the considerable variations in blood pressure and the unstable heart rhythm. Hematopoietic changes in monkeys in response to radiation had a phase character, demonstrating the different course of the radiation reaction in different types of cells. Since blood regeneration occurred even in monkeys dying after 30 to 36 days, it was concluded that blood changes were not the primary factor in animal deaths. The lower lethal dose values encountered in these experiments were partially explained by differing experimental conditions, but required further study. (ATD)

23670 RBE OF HIGH-ENERGY PROTONS. Darenskaya, N. G.; Derbeneva, N. I.; Nefedov, Yu. G.; Ryzhov, N. I.; Seraya, V. M.; Domshlak, M. P. pp 235-41 of Voprosy Obshchei Radiobiologii. Domshlak, M. P. (ed.). Moscow, Atomizdat, 1966. (In Russian).

The RBE of 510-, 240-, and 126-MeV protons was studied in comparative experiments with dogs, rats, and mice. A proton flux generated by the OIYaI synchrocyclotron at Dubna was used. Polyethylene and lead absorbers were used to decrease proton energies from 660 MeV, at the same time increasing the beam diameter to enable irradiation of large animals. The dose rate varied from 0.3 to 1.5 rad/sec. Rats and mice were irradiated in a rotating chamber and dogs were irradiated from two sides in order to equalize the dose distribution. RBE values were determined during both single and multiple irradiation: during multiple irradiation dogs were exposed eight to 19 times in the course of two to five weeks for total doses of 200 to 690 Rad, and rats were exposed 20 times in the course of four weeks for total doses of 750 and 1115 Rad. Single proton doses amounted to 136 to 550 Rad for dogs and 100 to 1200 Rad for rats and mice. It was observed that irradiation of dogs with small doses of protons altered their immunological reactivity, as indicated by the depressed phagocytic activity of neutrophils in the first days after irradiation. In proton-irradiated dogs a decrease in oxidative processes was also noted: CO_2 liberation and oxygen consumption dropped 35 to 50% shortly after irradiation and remained depressed until the animal died or until most radiation sickness symptoms disappeared. Experimental results showed the same periods of appearance of various symptoms of radiation sickness (such as increased temperature, diarrhea, and changes in peripheral blood, for proton- and gamma-irradiated dogs (except that dogs irradiated once with 510-MeV protons developed symptoms somewhat earlier). RBE values for protons in the energy range indicated were based on comparison of percentage survival, duration of life of surviving animals, severity of individual symptoms and results of laboratory tests. It was concluded that the RBE for dogs during multiple irradiation with 510- and 126-MeV protons was 1.0. For single irradiation, the RBE was 1.15 for 510- and 240-MeV protons, and 1 for 126-MeV protons. It should be noted that these RBE determinations were made on the basis of direct radiation effects, and may have to be altered for long-term radiation effects. Analogous experiments were conducted with white rats weighing 180 to 220 g and mice weighing 18 to 22 g. It was found that the RBE of 510-, and 240-, and 126-MeV protons for rats was 0.75, 0.73 and 0.69, respectively, based on the $LD_{50/30}$. The RBE based on the $LD_{100/30}$ was 0.75 for 510-MeV protons, and 0.79 for 240- and 126-MeV protons. For mice the RBE value for 126-MeV protons was set at 0.7. The difference in RBE values obtained for small and large animals was considerable, and indicated the danger of extrapolating data from small animals for study of the spaceflight radiation hazard to man. (ATD)

23671 DEPENDENCE OF TIME-TO-DEATH OF MICE ON DOSE RATE UNDER CONDITIONS OF CONTINUOUS IRRADIATION. Koznova, L. B.; Grinev, V. S. pp 255-65 of Voprosy Obshchei Radiobiologii. Domshlak, M. P. (ed.). Moscow, Atomizdat, 1966. (In Russian).

Dependence of time-to-death on dose rate was studied in mice continuously exposed to gamma rays until dead for a wide range of dose rates (from 1.6×10^{-2} to 8.6×10^{2} R/sec) by computer (Ural-2) analysis of data in the literature. An equation was derived to express cumulative lethality during the life span of the animals. A mathematical model of the processes operating during continuous irradiation, namely, the decline of viability, reparative processes and the development of reversible changes was presented. The relation of death to central nervous system damage was discussed. The computer analysis of the survival time of mice established the dependence of mean life expectancy on dose power and presented a basis for a mathematical model of death due to continuous radiation at a constant dose. (F.M.M.)

23672 INTRODUCTION TO RESEARCH IN ULTRAVIOLET PHOTOBIOLOGY. Jagger, John. Prentice-Hall Biological Techniques Series. Englewood Cliffs, N. J., Prentice-Hall, Inc., 1967. 173p.

Techniques of ultraviolet radiation in biological research are emphasized. A short theoretical discussion of the ultraviolet spectrum, the photon, macroscopic aspects, and microscopic aspects is presented. A discussion of equipment with regard to sources, isolation of bands, and measurement is included. A description of experiments dealing with absorption, inactivation and mutation, and action spectra is given, and modifications and hazards are pointed out. Actions and mechanisms of action of ultraviolet radiation are discussed with regard to small molecules, large molecules and viruses, small cells (bacteria), large cells (protozoa), and the origin of life. There is an appendix giving physical equivalents, terminology of radiometry, photometry, and dosimetry, potassium ferrioxalate actinometry, and manufacturers of ultraviolet apparatus. An extensive bibliography is included. (H.L.W.)

23673 PROMIENIOWANIE ELEKTROMAGNETYCZNE WIELKIEJ CZESTOTLIWOSCI. DZIALANIE BIOLOGICZNE I OCHRONA ZDROWIA. (High Frequency Electromagnetic Radiation. Biological Effects and Health Protection). Minecki, L. Warsaw, Wydawnictwo Zwiazkowe CRZZ, 1967. 143p. 25 Zlotys.

A survey of present knowledge of the biological action of high-frequency electromagnetic radiation is presented. A considerable portion of the work is devoted to the effect on various organs and systems of the body (nervous system, gonads, eyes, endocrine glands, blood, hematopoietic organs, enzymes, tissues). In addition the effect of this radiation on the development of the embryo, mutations and cell-division is also considered. A special chapter is devoted to data on the combined effects of high-frequency and ionizing radiations. Information is given on protection against the harmful effects of high-frequency electromagnetic radiation in industry. Appended to the text are the complete Polish statutory provisions. The brochure is intended mainly for industrial physicians and labor inspectors. (Occup. Safety and Health Abstr.)

Radiation Effects on Plants

Refer also to abstracts 23138, 23424, 23430, 23438, 23461, 23468, 23470, 23479, 23481, 23485, 23487, 23488, 23490, 23498, 23500, 23501, 23580, 23667, 23672, and 23694.

23674 (NYO-3561-4) THE USE OF TRITIATED THYMIDINE AS AN INTERNAL SOURCE OF IRRADIATION IN THE STUDY OF LATERAL ROOT INITIATION. Progress Report, 1967-1968. Stein, Otto L. (Massachusetts Univ. [Amherst]). 18p. Dep. CFSTI.

Scintillation counting of roots of intact corn seedlings grown in tritium-labeled thymidine or tritium-labeled water disclosed a similar pattern of tritium uptake. In the culture solution the tritium concentration per root was 500 times higher in tritium-labeled water than in tritium-labeled thymidine, yet maximum incorporation was 500 times higher in tritium-labeled thymidine treated roots. A region of high isotope uptake was observed 2 cm from the apical meristem; however, this does not correspond to the portion of the root in which we reported earlier a higher percentage of stellar nuclei labeled, presumably being responsible for inhibition of lateral roots in that region. Growth of root tip segments in sterile culture media showed that both uridine and

thymidine at low concentration (0.183 and 0.127 ppm/5 roots/20 ml, respectively) may be inhibitory. Higher concentrations facilitate a return to control value. This suggests the presence of a feed-back system. (auth)

23675 RELATION OF RADIOSENSITIVITY OF PLANTS WITH PHYLOGENETIC AGE. Preobrazhenskaya, E. I. Izv. Sib. Otd. Akad. Nauk SSSR, Ser. Biol.-Med. Nauk, No. 5, 79-84 (Apr. 1967). (In Russian).

The general radiosensitivity of plants was correlated with their phylogenetic age. The old primitive types of plants were more radiosensitive than complete young forms. In the conifers the radiosensitivity of the family, genus, and species was stable. In the dicotyledons there was sharp variability in the radiosensitivity; monocotyledons occupied a middle position. The differences in the radiosensitivity of the plants were very strongly shown by systematically moving from one group to the other. At the limits of the taxonomic group a dependence of the radiosensitivity on phylogenic age was demonstrated. The guiding significance of other evolutionary characteristics such as seed dimensions, dimensions and number of chromosomes, structure of protective substances, and ecology is discussed. (tr-auth)

23676 STIMULATION OF THE GROWTH IN THE ONION ALLIUM CEPA AFTER STORAGE OF THE BULB DURING SPACE FLIGHT ON THE SPUTNIK COSMOS-110. Delone, N. L.; Morozova, E. M.; Antinov, V. V.; Parfenov, G. P.; Trusova, A. S. Kosm. Issled., 5: 939-43(Nov.-Dec. 1967). (In Russian).

As a result of the radiation exposure during space flight of bulbs of Allium cepa during the flight of Cosmos-110, a stimulation of the growth during the 10 days of sprouting was observed. Differences in the dimensions of the cells in some areas of the rootlets in the test and control plants were not observed. Calculations were made of the chromosome aberrations and mitotic indices. An increase of the number of chromosome aberrations in the test plants in comparison with the control plants was observed. (tr-auth)

23677 GAMMA RADIATION EFFECTS ON SUGAR CONTENT IN SUGAR BEETS. Millers, A. (Inst. of Biology, Riga). Latv. PSR Zinat. Akad. Vestis, No. 10, 89-93(1967). (In Latvian).

Field experiments were conducted in Latvia to study effects of gamma radiation on productiveness and crop quality of sugar beets following seed exposure. It was found that a dose of 2000 R increased the sugar content and rate of ripening of the plants. Effects of radiation varied with varieties of sugar beets. The best results were obtained with variety M070. (TSS)

23678 STUDIES ON THE PIGMENT PRODUCTION IN UV-INDUCED MUTANTS OF PENICILLIUM PURPUROGENUM. Chattopadhyay, Sisir; Chaudhuri, Kantilal (Bose Inst., Calcutta). Sci. Cult. (Calcutta), 33: 343-4(July 1967).

Pigment production in uv-induced mutants of Penicillium purpurogenum was studied. The pigment purpurogenone was isolated from the mycelium of a strain of Penicillium, chemically purified, and its molecular formula established. It was identified as a benzoquinone type of compound. Mutants induced by exposure to uv radiation showed various colors of spores and differences in pigment production, covering a range of reddish purple in the substrate. In some cases restricted pigment production was observed. (C.H.)

23679 AN ACTION SPECTRUM OF PHOTOMORPHOGENESIS UNDER HIGH-ENERGY CONDITIONS AND ITS INTERPRETATION ON THE BASIS OF PHYTOCHROMES. STUDIES ON HYPOCOTYLS OF LACTUCA SATIVA L. Hartmann, Karl M. (Univ., Freiburg i. B.). Z. Naturforsch., 22b: 1172-5(Nov. 1967). (In German).

Control by light of hypocotyl lengthening in lettuce seedlings (Lactuca sativa L., cv. Grand Rapids, tip burn resistant strain) was investigated using high quality monochromatic bands of radiation between 320 and 1100 nm wave length. Continuous irradiation was applied between 54 and 72 hours after sowing. The increase of hypocotyl length during this period was measured. —A set of characteristic dose-response-curves is presented. For the calculation of the action spectrum — relative quantum efficiency (N_{447nm}/N_λ) as a function of wavelength — the branches of the dose-response-curves between 60 and 80% increase were used. The action spectrum shows a symmetric peak around $\lambda = 716$ nm with a band width of 30 nm. This fact agrees with the conclusion that the far-red peak of action in the case of long-time irradiation is exclusively due to phytochrome. The photostationary state $[P_{fr}]/[P]$ for optimum effectiveness with respect to control of hypocotyl lengthening in lettuce is probably around 3%. —The fine structure of the action spectrum in the blue and ultraviolet range (especially the peak around $\lambda = 363$ nm) points to a flavoproteid as the photoreceptor. On the other hand it is well known that with long-time irradiation short wavelength light as well will maintain photostationary states of the phytochrome system. Further experiments are required to solve the problem of how much of the effect of blue and ultra-violet light can be attributed to phytochrome. (auth)

23680 EFFECT OF γ-IRRADIATION ON THE FORMATION OF STOMATA IN LUPINUS ALBUS COTYLEDONS. Nalborczyk, E. (Agricultural Univ., Warsaw). Bull. Acad. Pol. Sci., Ser. Sci. Biol., 15: 377-83(1967).

Seeds of bitter white lupin (Lupinus albus) were air-dried and soaked in water, cysteine solutions, and plant extract solutions. The seeds were exposed to γ irradiation from a ^{60}Co source and placed in tap water. After 10 days the number of epidermal cells and stomata on the under surface of the cotyledons were counted. Irradiation of seeds resulted in a reduced number of stomata. Higher doses of radiation were required for air-dried than for soaked seeds. The formation of stomata was further inhibited by solutions of cysteine and plant extracts. Results are shown in the form of tables and graphs. (H.L.W.)

23681 THE RADIOSENSITIVITY OF CORN AND BARLEY IN DIFFERENT STAGES OF DEVELOPMENT UNDER CHRONIC γ IRRADIATION. Berezina, N. N.; Pecknikov, N. V. (Inst. of Biological Physics, Moscow). Radiobiologiya, 7: 932-4(1967). (In Russian).

Corn and barley plants were irradiated at times corresponding to different phases of development at total stimulating doses of 402 to 431 R for corn and a total inhibiting dose of 5 kR for barley. The radiosensitivity of the plants differed greatly in the phases. The maximum effects of irradiation being noted in the phase of organ differentiation. Chronic irradiation during the vegetative period led to the same increase of yield as irradiation in the phase of organ differentiation. (JPRS)

23682 RADIATION RESISTANCE OF PLANTS AND PHYLOGENY. Preobrazhenskaya, E. I. (Agrophysical Scientific Research Inst., Leningrad). Dokl. Akad. Nauk SSSR, 177: 243-5 (Nov. 1, 1967). (In Russian).

Experiments were carried out with 700 plants belonging to different taxonomic groups to verify the assumption that their radiation resistance depends on their position in the phylogenetic system. The plants were divided into three groups on the basis of their survival rate at the end of the vegetative cycle including a radiosensitive group with $15 \leq LD \leq 25$; an average group $25 \leq LD \leq 100$ and a radiation resistant one with $100 \leq LD \leq 200$ to 300 300 kR. Previous results indicated that all gymnosperms were radiosensitive; the angiosperms were represented in all three groups. The radiation resistance increased from conifers to monocotyledons and dicotyledons. Study of the phylogenetic system of angiosperms indicated that the evolutionary advancement of the orders results in an increase of their radiation resistance, with a possible exception of the order Betulales. (TTT)

Radiation Effects on Microorganisms

Refer also to abstracts 23398, 23410, 23411, 23421, 23430, 23432, 23455, 23457, 23476, 23495, 23499, 23672, and 23702.

23683 (UCRL-17481, pp 138-44) SENSITIVITY OF MICROCOCCUS RADIODURANS TO DENSELY IONIZING RADIATIONS. Dewey, David L.; Haynes, Robert H.

The radiation dose-survival curves for M. radiodurans were measured for a number of 10 MeV/amu heavy-ion beams produced by the Berkeley Hilac. All the curves, even for the highest LET available, were found to have a broad shoulder approximately 1 Mrad long. For the values of LET up to about 1000 MeV-cm^2/g (i.e., helium, lithium, and boron beams), the apparent limiting slope of the curves increases by about a factor of 3, but there is little change in the magnitude of the shoulder over this range of LET. For values of LET greater than 1000 MeV-cm^2/2 (i.e., carbon, oxygen, neon and argon beams) the shoulder increases and the slope decreases, indicating a general decrease in the relative biological efficiency over this range of LET. Addition of acridine orange to the plates used to assay survival serves to increase the apparent sensitivity of the cells for all values of LET used. This may be taken as further evidence that the resistance of M. radiodurans is caused by its possession of a very efficient DNA repair mechanism and that the damage produced by high-LET radiations can be repaired in this organism. (auth)

23684 AEROSOLS OF MYCOPLASMAS, L FORMS, AND BACTERIA: COMPARISON OF PARTICLE SIZE, VIABILITY, AND LETHALITY OF ULTRAVIOLET RADIATION. Kundsin, Ruth B. (Peter Bent Brigham Hospital, Boston). Appl. Microbiol., 16: 143-6(Jan. 1968).

Aerosols of microorganisms were tested for particle size by use of an Andersen sampler. Mycoplasma aerosols had an average

count median diameter (CMD) of 2.1 ± 0.5 μ. Staphylococcus aureus L forms gave an average CMD of 4.6 ± 1.7 μ; the diphtheroid L form, a CMD of 3.4 ± 0.3 μ. Escherichia coli had a CMD of 5.4 ± 2.5 μ; Neisseria sicca, 3.3 ± 0.5 μ; N. meningitidis, 3.4 ± 0.2 μ. S. aureus ATCC 6538, the parent strain of the L form, yielded a CMD of 3.9 ± 1.2 μ. Candida albicans gave an average CMD of 5.9 ± 1.4 μ. All organisms tested survived aerosolizing and could be recovered in viable form for at least 1 hr. Ultraviolet radiation at 2,537 A destroyed the bacteria and mycoplasmas instantaneously, and destroyed 87% of the L forms of S. aureus, 69% of the diphtheroid L form, and 98% of the C. albicans cells. After irradiation, viable particles of the L form and C. albicans aerosols were consistently larger, indicating that clumping led to survival. Submicron size particles were found in aerosols of all species tested except C. albicans. (auth)

23685 INFLUENCE OF DOSE RATE AND TIME FACTOR ON BACTERICIDAL EFFECT OF IRRADIATION. Pershina, Z. G.; Koznova, L. B.; Sobolev, S. M.; Khrushchev, V. G. pp 273-7 of Voprosy Obshchei Radiobiologii. Domshlak, M. P. (ed.). Moscow, Atomizdat, 1966. (In Russian).

Experiments were conducted on vegetative microorganisms, Escherichia coli 613, and on spore forming microorganisms, Bacillus anthracis, to determine the influence of dose rate and time on the bactericidal effect of irradiation. B. coli 613 were γ irradiated with single 50 kR doses at dose rates of 111.5 R/min (7 hr 29 min), 334.5 R/min (2 hrs 29 min), 600 R/min (83 min 20 sec) and 14,760 R/min (3 min 23 sec). The highest bactericidal effects were found with dose rates of 111.5 and 334.5 R/min. Similar results were found with irradiation of B. coli 613 with a 100,000 R dose at dose rates of 107 R/min (15 hrs 35 min) and 320 R/min (5 hrs 12 min 30 sec). A complete bactericidal effect was achieved with the 107 R/min dose rate, while with the 320 R/min dose rate the bacterial colonies increased by 2.3×10^{-5}%. In experiments on B. anthracis, irradiation with a 800,000 R dose at a dose rate of 174 R/min produced a complete bactericidal effect, whereas a dose rate of 48,000 R/min increased the number of bacteria by 9×10^{-3}%. With irradiation of bacteria in higher concentrations using the same dose, a comparable dependence of bactericidal effect on dose rate was found, but was less markedly expressed. Experimental data showed that increase of irradiation time in the dose rate range of 111.5 to 48,000 R/min increased the bactericidal effect. Future studies should be directed toward finding optimal irradiation conditions for complete bactericidal effects. (ATD)

23686 INHIBITION OF OXYGEN UTILIZATION AND DESTRUCTION OF UBIQUINONE BY ULTRAVIOLET IRRADIATION OF THIOBACILLUS THIOOXIDANS. Adair, Frank W. (Rutgers-The State Univ., New Brunswick, N. J.). J. Bacteriol., 95: 147-51(Jan. 1968).

Ultraviolet (UV) irradiation inhibited sulfur oxidation by cells of Thiobacillus thiooxidans. Sulfur-oxidizing activity decreased as the exposure time to UV light increased. A loss of the ability of cells to fix CO_2 paralleled the loss of sulfur oxidizing activity. UV light photoinactivated ubiquinone purified from T. thiooxidans. The same percentage of sulfur-oxidizing activity and ubiquinone was destroyed after 15 min of UV exposure. Both the photoinactivation of sulfur oxidation and ubiquinone followed first-order reaction kinetics. The specific rate constants for both photoinactivations were nearly equal. Cells completely inactivated by UV light contained no ubiquinone. Ubiquinone was found to be a component of the cell wall-membrane complex. (auth)

23687 EFFECTS OF THE RARE EARTH CERIUM ON ESCHERICHIA COLI. Sobek, Joseph M.; Talburt, Dwight E. (Univ. of Southwestern Louisiana, Lafayette). J. Backeriol., 95: 47-51 (Jan. 1968). (ORNL-P-3416).

The rare earth cerium was found to bind rapidly to Escherichia coli. Cerium inhibited oxygen uptake in the presence of glucose as well as the endogenous respiration of glucose-grown cells. For a cell concentration of 4 mg per ml, maximal inhibition was obtained at 120 μg per ml. Greater concentrations did not increase the inhibitory effect. Cerium inhibited $^{14}CO_2$ evolution and ^{14}C uptake from uniformly labeled glucose. Marked changes in the distribution of ^{14}C incorporated into different chemical fractions of the cell were noted. The most striking changes occurred in the alcohol- and alcohol ether-soluble fractions, in which the ^{14}C activity was increased 5- to 20-fold in the presence of cerium. (auth)

23688 INFLUENCE OF HEAVY WATER (D_2O) ON THE MULTIPLICATION OF ADENO AND MENGO VIRUS. Carp, R. I.; Kritchevsky, D. (Wistar Inst. of Anatomy and Biology, Philadelphia). Experientia, 23: 786-7(Sept. 15, 1967).

Adeno virus was grown in a culture of human embryo kidney (HEK) cells, and Mengo virus was grown in a culture of I cells. The medium for one half of the experiments contained deuterium oxide; controls contained H_2O. After 24 and 48 hours the titer of the Adeno virus was significantly higher in the medium containing H_2O than in the medium containing deuterium oxide. The rate of multiplication of Mengo virus was initially slower in deuterated medium, but at 24 and 48 hours there was no difference between the titer of virus grown in H_2O or D_2O. (H.L.W.)

23689 DARK REACTIVATION OF UV DAMAGE AND NITROSOGUANIDINE RESISTANCE IN STREPTOCOCCUS PYOGENES. Malke, Horst (Deutsche Akademie der Wissenschaften zu Berlin, Inst. fuer Mikrobiologie und Experimentelle Therapie, Jena, Ger.). Z. Naturforsch., 22b: 1139-43(Nov. 1967). (In German).

The resistance to N-methyl-N'-nitro-N-nitrosoguanidine (NG) of five single-step mutants of a lysogenic group A Streptococcus after several cycles of growth in NG-free media was within the range of 1.5 to 3.7 times that of the parent. After ultraviolet irradiation (uv) these mutants had a higher chance to survive than the wild type, giving dose reduction factors of 1.4 to 2.4. In prophage induction experiments using uv and NG as inducing agents, the dose induction functions of the NG-resistant strains were either shifted toward higher doses or the efficiency of induction was decreased. In the strains examined caffeine and acriflavine (which are already known to block host cell reactivation) greatly enhanced both the killing and the inducing effect of uv, indicating the ability of Streptococcus pyogenes to perform dark repair of uv damaged DNA. The extra resistance to uv conferred on the strains carrying the NG-resistance mutation was not decreased by uv enhancers, moreover, their action on dark reactivation seemed to be less efficient in these strains. (auth)

23690 EFFECTS OF SOME CHEMICALS ON THE RECOVERY OF RADIATION DAMAGE OF STREPTOMYCES STRAIN $Ac_{21}460$. Chakrabarty, Sankar Lal; Nandi, P. (Bose Inst., Calcutta). Trans. Bose Res. Inst. (Calcutta), 28: 113-17(Dec. 1965).

A pink colored Streptomyces sp. isolated from Indian soils and designated as Streptomyces strain $Ac_{21}460$ was irradiated by ultraviolet rays (2537 Å) for 20, 40, 60 and 80 seconds respectively at 100 ergs/mm²/sec. The modifying effects of some chemicals on the survival and on the rate of mutation were studied. Simple inorganic compounds such as NaCl, KCl, $MgSO_4$, $CaCl_2$ and $FeSO_4$ were added separately to the spore suspension as possible reactivating agents during irradiation and in agar medium used for plating after irradiation at concentrations of 10 mg/ml. It was observed that the lethal and the mutagenic effects of ultraviolet rays could be reversed in the presence of these salts. The percentage of survival increased in all cases of treatment except by means of $FeSO_4$ which was toxic. The rate of mutation decreased with the rise of survival percentage. The results show that the lethal and mutagenic effects of ultraviolet rays could be reversed to some extent by giving a treatment with chemicals during irradiation and post-irradiation stages. (auth)

Radiosterilization and Radiopreservation

Refer also to abstracts 23481, 23593, and 23618.

23691 (AECL-2706) GAMMA IRRADIATION IN CANADA, VOLUME V. (Atomic Energy of Canada Ltd., Ottawa (Ontario). Commercial Products Div.). Oct. 1967. 130p. Dep. CFSTI. CAN $1.00.

Separate abstracts were prepared for five of 12 papers presented. Eight papers were previously included in NSA under abstract numbers: 15945, 16528, 23562, 41496, 43545, 43548, and 43549. (E.R.B.)

23692 (AECL-2706, pp 50-9) PROGRAMS IN FOOD AND INDUSTRIAL IRRADIATION. Lillie, A. B. (Atomic Energy of Canada Ltd., Ottawa (Ontario). Commercial Products Div.).

Applications of large irradiation sources in industry in Canada are reviewed. The food industry now shows the greatest potential for applications of large radiation sources. Radiation processing was found to be effective: for the control of sprouting of stored onions and potatoes; to prevent the loss of sugar content of stored sugar beets; to extend the storage life of apples, apricots, bananas, peaches, pears, plums, and strawberries by sterilization of bacteria, fungi, and insects that cause spoilage; to control bacterial attack on fish and sea foods; to reduce deterioration in poultry and poultry products and other meats caused by bacterial attack; to inhibit cap opening of mushrooms; to control insect infestation in stored cereals such as rice and wheat; and to reduce the rehydration time of dehydrated vegetables. Research studies in progress on the radiation resistance of microorganisms and enzymes involved in food deterioration are mentioned. The development of ^{60}Co mobile food irradiators is also mentioned. Foreign food irradiation programs of significance to Canada are outlined. Other

industrial applications of radiation on which some research has been done include the sterilization of medical supplies, the development of wood-like material of increased strength and hardness and lower water absorption by the γ-induced polymerization of wood impregnated with a suitable monomer, and the improvement of characteristics of natural and synthetic fibers, fabrics, films, and powders by a grafting technique wherein a small group or a polymer is chemically attached to a base material at sites created by irradiation. (C.H.)

23693 (AECL–2706, pp 114-21) EFFECT OF FEEDING IRRADIATED ONION TO THE RAT FOR 1 YEAR. Van Petten, G. R.; Oliver, W. T.; Hilliard, W. G.

Published in Food Cosmet. Toxicol., Dec. 1966.

Non-irradiated or γ-irradiated (8 and 100 krad) onions were incorporated into the diet of rats in amounts equivalent to 10 and 25% wet-weight and the animals were maintained on this diet for one yr. Observations of clinical condition, weight gain, reproduction, hematology, and gross and microscopic pathology revealed no adverse effects. (auth)

23694 (IA–1128, pp 168-84) IRRADIATION OF AGRICULTURAL PRODUCTS. (Israel Atomic Energy Commission, Tel Aviv).

Potatoes were irradiated and stored at various temperatures. At temperatures of 4° and 8°C sprouting was inhibited, but no inhibition was observed at 14°C or at room temperature. These results were compared with the effects of the chemicals, CIPC and MH-30, on sprouting. Studies were continued on radiation control of sprouting in stored onions. Sprouting was inhibited in onions by doses of 2, 7, and 12 krads. Irradiation also decreased the weight loss during storage. Sprouting was controlled in garlic by a 12.5 krad dose of radiation. Experiments with seed potatoes showed that small doses of radiation accelerated germination and increased the yield. When onion bulblets were irradiated with 300 rads eight days before planting, a better yield was obtained than with controls. When the dose was increased to 600 and 1000 rads the yield was reduced. Onion seeds were irradiated with doses of 300, 600, and 900 rads and planted 33 days later. The yield was increased with the 600 rad dose. Seeds irradiated with doses of 300 and 600 rads germinated and grew more quickly than controls during the first four weeks. Oranges and grapefruit were treated with radiation and stored at 4° and 15°C. With doses of 10 krads or more, peel damage was observed, but taste and color of the juice were not affected by the largest doses. Radiation damage to the peel was slower at 4° than at 15°C. Extent of the damage increased significantly with the dose. Shamouti oranges from two different rootstocks in two types of soil were irradiated with doses of 55 to 240 krads. There was no difference between the two groups with regard to peel damage; however, there were marked differences between them with regard to peroxidase activity. Grapefruit were irradiated with 30 to 240 krads and stored at 14° to 18°C. Citric acid and total soluble solids in the juice were not affected by radiation. Ascorbic acid was affected only by the highest doses. Peel damage was marked after eight days. Oranges were exposed to beta and gamma radiation. Gamma rays had greater effects on ascorbic acid, while beta rays caused greater changes in peroxidase and catalase activities. Effects of radiation on fruit during development showed markedly different reactions in fruits of different maturity stages. Effects of radiation on ascorbic acid, catalase activity, reducing sugars, and respiration rate in the two parts of the peel were studied. Experiments on strawberries indicated that irradiation alone did not greatly reduce the amount of spoilage. Doses of 20 to 60 krads caused delay of ripening in bananas stored at 17°C. Skin darkening was caused by radiation, but there were no deleterious effects in the appearance or taste of the edible portion. Doses of 50 to 200 krads caused delay in ripening of avocado pears; the peel and edible portions of the fruit were seriously damaged. (H.L.W.)

23695 (UCD–34P–80–5) RADIATION TECHNOLOGY IN CONJUNCTION WITH POSTHARVEST PROCEDURES AS A MEANS OF EXTENDING THE SHELF LIFE OF FRUITS AND VEGETABLES. Period Covered: February 1, 1966–January 30, 1967. Maxie, E. C.; Sommer, N. F.; Brown, D. S. (California Univ., Davis. Dept. of Pomology). Apr. 1968. Contract AT-(11-1)-34. 177p. Dep. CFSTI.

Mechanical injury stimulated ripening in banana fruits by stimulating the production of the ripening hormone, ethylene gas (C_2H_4), by wounded tissues. Gamma irradiation at doses of 35 to 50 kilorad (Krad) offset the ripening stimulus of wounded tissues, apparently by reducing the sensitivity of the bananas to the ripening action of the gas. Shasta strawberry fruits subjected to 200 Krad of gamma rays in the Mobile Gamma Irradiator (MGI) showed considerably less rot (8.9 vs. 37.1% in simulated marketing) following air shipment from San Francisco, California, to New York, New York. Measurements of flesh color in irradiated Elberta peaches using the Gardner Automatic Color Difference Meter confirmed earlier results indicating an increased amount of red pigments in the irradiated fruits. Heat treatments in combination with irradiation did not adversely affect pigment development. Irradiation to 100 Krad substantially reduced cap opening and stem growth in brown mushrooms subsequently stored at 41° and 68°F. No benefit was found if a storage temperature of 32°F was employed. Doses of 100 Krad did not significantly affect aroma and flavor or the ascorbic-acid content of mushrooms. Quality, ripeness, per cent soluble solids, flesh color, and flavor of cantaloupes were not adversely affected by gamma rays at doses below 400 Krad. The flesh of cantaloupes was markedly softened by irradiation, but the differences between irradiated and unirradiated fruits disappeared as the fruit ripened. There was a substantial loss in ascorbic acid in irradiated cantaloupes, apparently directly related to dose. Honeydew melons responded similarly to gamma irradiation as did cantaloupes in most respects. However, this fruit could tolerate doses as high as 800 Krad with an adverse effect on flavor. This apparent advantage was offset by an extreme sensitivity of the textural components of the fruit to irradiation. Gamma irradiation to 300 and 400 Krad increased the susceptibility of tomato fruits to transit injury. This adverse effect was markedly reduced by packaging the fruits in a manner that precluded movement within the package. The Mobile Gamma Irradiator is now functional. This unit can process 600 pounds of strawberries and peaches and 700 pounds of tomatoes per hour. For germination-inhibiting doses of potatoes and onions, the capacity is 3,600 to 5,600 pounds per hour depending on varietal dose requirements. The dose variation within product packages seems acceptable to the objectives of the unit. There was a marked synergistic interaction between heat and gamma irradiation that increased the fungicidal effectiveness of irradiation without noticeable added host damage. This offers the promise of feasibility of irradiation as a technology for several commodities previously considered too sensitive to the treatment. (auth)

23696 GAMMA IRRADIATION TO EXTEND POSTHARVEST LIFE OF FRUITS AND VEGETABLES. Mercier, R. G.; MacQueen, K. F. (Atomic Energy of Canada Ltd., Ottawa). Food Technol., 20: 105-7(Feb. 1966). (AECL–2706, pp 60-80).

Cobalt-60 gamma irradiation was found to have potential commercial uses for extending shelf- and storage-life of apples, apricots, mushrooms, peaches, pears, plums, and strawberries. The most striking results were obtained with mushrooms (inhibition of cap opening) and strawberries (reduction in decay), and preliminary work towards an application for a Food and Drug Clearance for commercial trials is justified. In general, a dose of 200 kilorads gave the best results; 300 was often too high, and caused varying degrees of skin damage; 100 was too low except with apples. Irradiation did not benefit, and was often harmful to asparagus, blackberries, sweet and sour cherries, and raspberries. More work is needed before an evaluation of the merits of irradiation of sweet corn, grapes, and tomatoes can be made. With mature fruit, precooling in a 34°F storage room prior to irradiation gave better results. Peaches treated while too immature (25 to 30 lb. pressure) and too green to market, developed good color, often a pink blush, and the flavor and texture became quite acceptable. This is a possible commercial application, if it is found necessary to harvest a portion of the crop in an immature state. Irradiation caused a preliminary softening of the fruits, but the opposite was found to be true after one or two days at room temperature, and irradiated lots remained firm longer. CO_2 release was also higher at first, but, in time, slowed down to a rate below that of the check. After irradiation of mature fruit, but not with immature fruit, the flesh became more mealy, less juicy than the untreated lots. Flavor was somewhat changed by irradiation, but in all probability, not noticeably so to the average consumer. (auth)

23697 GAMMA IRRADIATION OF BLOOD AGAR PLATES. Harris, B. D.; Warner, Peter (Winnipeg General Hospital, Manitoba). Can. Med. Ass. J., 94: 1188(May 28, 1966). (AECL–2706, pp 129-30).

Blood agar plates were prepared and exposed, in sealed polyethylene bags, to ^{60}Co γ-rays to a dose of 2.85 to 2.98 Mrads. The plates were then stored at room temperature and remained sterile for up to 15 days. Inoculation of plates at various intervals with hemolytic bacteria indicated no impairment of nutritional value in the plates, nor in their ability to support the growth of these bacteria. Two apparent disadvantages of γ-sterilization of the plates were: radiolysis of the blood cells, and development of a soft, wet texture in the agar. Methods of overcoming these undesirable effects are discussed. (E.R.B.)

23698 PROTEOLYTIC ACTIVITY OF MICROORGANISMS ISOLATED FROM FRESHWATER FISH. Kazanas, Nuria (Bu-

reau of Commercial Fisheries Technological Lab., Ann Arbor, Mich). Appl. Microbiol., 16: 128-32(Jan. 1968).

A raw fish-juice was prepared and sterilized through the use of ^{60}Co γ irradiation. It was evaluated for suitability in an agar medium for testing the proteolytic activity of bacteria isolated from fish. Microorganism proteolytic activity was also detected by conventional methods with skim milk-agar. We tested 1,145 isolates from fresh and spoiling irradiated (0.0, 0.3, and 0.6 Mrad) yellow perch fillets for proteolytic activity, by the use of both media. Most isolates that showed proteolytic activity exhibited this activity in both media. A few isolates showed proteolytic activity only in one medium or the other. Proteolysis was found mainly among bacteria isolated from nonirradiated perch fillets. Nonproteolytic organisms were slightly more abundant than were proteolytic ones throughout refrigerated storage (6 days); the latter constituted 48% of the total organisms. Irradiation eliminated essentially all proteolytic bacteria when the fillets were stored at 1 C. However, some proteolytic bacteria survived for a few days after irradiation when the fillets were stored at 5 C. (auth)

23699 EFFECTS OF GAMMA RADIATION ON THE FERTILITY OF THE TORSALO, DERMATOBIA HOMINIS (DIPTERA: CUTEREBRIDAE). Banegas, A. D.; Mourier, H. (Laboratorio Veterinario San Jose, Honduras, Central America). Ann. Entomol. Soc. Amer., 61: 23-6(Jan. 1968).

Pupae of the tórsalo (human bot fly), Dermatobia hominis (L., Jr.), which had completed 20, 25, and 30 days, respectively, of their pupal development were exposed to doses of 5000, 7500, and 10,000 R γ radiation from a ^{60}Co source. These exploratory tests indicated that the best age for treating pupae was 25 days, representing about 5/7 of their development at 25°C. All dosages drastically reduced fertility of the flies, but the results obtained here suggest that 7500 R (which completely inhibited development of ova in females and reduced male fertility to 0.8%) is the appropriate dosage for practical use in control of this fly by sterile-male release. Behavior and appearance of the treated flies appeared normal; mating frequency of males treated with 7500 R was like that of normal males, and they competed equally with untreated males for mates in small cages. Sperm of treated males were motile and equaled in quantity that of untreated flies. (auth)

23700 INHERITED PARTIAL STERILITY AMONG SURVIVORS FROM IRRADIATION-ERADICATION EXPERIMENT. Walker, David W.; Quintana, Victor (Puerto Rico Nuclear Center, Mayaguez). Contract AT(40-1)-1833. J. Econ. Entomol., 61: 318-19(Feb. 1968).

Males and females of the sugarcane borer, Diatraea saccharalis, were exposed to low doses of γ radiation and few of the offspring died. The surviving offspring were collected and mated to normal moths of the opposite sex. It was found that few of the offspring survived whether the original irradiated parent was a female or a male. (H.L.W.)

23701 RADIATION STERILIZATION OF MEDICAL DEVICES AND SUPPLIES. I. DISPOSABLE SYRINGES AND NEEDLES. Sato, Kenji; Ito, Nobuo (Tokyo Metropolitan Isotope Research Center). Eisei Kagaku, 13: 136-9(June 1967). (In Japanese).

Disposable polystyrene syringes with needles were γ-irradiated (^{60}Co) at various doses and were then subjected to sterility test, safety test, and function tests such as, breaking test, load test, and fluid tightness test. A dose of 3 Mrad completely sterilized samples heavily inoculated with Bacillus spores. Neither the occurrence of toxicity nor detrimental effect on the function of syringes was observed at this dose. It was concluded that 3 Mrad was a suitable dose for the radiation sterilization of disposable syringes and needles. (NSA of Japan)

23702 RADIATION TREATMENT OF CITRUS FRUITS. Sato, Tomataro; Kawashima, Koji (Food Research Inst., Tokyo). Nippon Shokuhin Kogyo Gakkaishi, 13: 443-50(Oct. 1966). (In Japanese).

Radiation pasteurization of vegetables and fruits, especially citrus fruits is reviewed. The lethal radiation dose (LD 80) for molds common in citrus fruits, e.g., the Penicillium group, ranged from 0.2 to 0.8 Mrads, and for their spores it was below 0.1 Mrad. The optimum radiation dose for the pasteurization of citrus fruits differed considerably with the kind of fruit, place of production, duration of storage, irradiation conditions, and other factors. In the navel oranges inoculated with spores of Penicillium italicum and irradiated with 200 Krads of γ rays, good quality was maintained for 20 days at 75°F and 65 days at 41°F; the nonirradiated oranges went bad within four days. Some reports were made that the higher dose rate was more effective with a constant total dose. Vitamins were stable to irradiation, with the exception of vitamin K that was 80% decomposed at a dose of 2.71 Mrads. The respiration quotient of fresh oranges was not changed by irradiation with 125 Krads, but increased with 180 Krads. This increase was only temporary and rapidly decreased a few days after irradiation. No unfavorable phenomena were reported on the safety of irradiated citrus fruits, such as the formation of poisonous substances, induced radioactivity, or decomposition of the nutritive constituents. (NSA of Japan)

23703 TREATMENT OF MEATS WITH IONISING RADIATIONS. XV. IRRADIATION OF BEEF FROM BARLEY-FED ANIMALS. Rhodes, D. N.; Roberts, T. A.; Shepherd, H. J. (Meat Research Inst., Cambridge, Eng.). J. Sci. Food Agr., 18: 576-8(Dec. 1967).

Joints of beef, γ-irradiated at a dose level of 0.4 Mrad, were stored at 2°C in plastic packages of differing gas permeabilities. Bacterial growth was reduced by the lack of oxygen and/or the accumulation of carbon dioxide. The irradiated meat remained unspoiled for at least 84 days. The useful shelf-life to the beef can be extended greatly by irradiation, but the undesirable color changes resulting from the exclusion of oxygen remains a serious drawback. (auth)

23704 TREATMENT OF MEATS WITH IONISING RADIATIONS. XIV. RADIATION PRESERVATION OF BACK CUTS OF GREEN BACON. Rhodes, D. N.; Shepherd, H. J. (Meat Research Inst., Cambridge, Eng.). J. Sci. Food Agr., 18: 456-9 (Oct. 1967).

Irradiation of vacuum-packed back cuts of green bacon with a dose of 0.44 Mrad delayed spoilage at 1°C from nine to more than 40 weeks, and at 5°C from four to more than 20 weeks. Organoleptic quality remained good throughout storage except for a slight irradiation odor, detectable in the raw product only. (auth)

23705 THE EFFECT OF γ IRRADIATION ON CORN AND PEA SEEDS. Pertsovskii, E. S.; Sharova, M. A. (All-Union Scientific Research Inst., of Grain and Products of its Processing, Moscow). Radiobiologiya, 7: 926-31(1967). (In Russian).

Seeds of corn with a moisture content of 11 to 12% and 20 to 21% and seeds of the pea with 13 to 14% and 20 to 21% were irradiated. The corn was irradiated at doses of 100, 250 and 500 krads and the pea with 100 krads at a dose rate of 11 krads/min and 80 krads/min. The materials were then dried, processed into coarse meal, and stored for two months under room conditions. Their quality was then evaluated on the basis of the total yield of meal, the yield of individual fractions, culinary qualities and the content of protein, fats and starch. It was found that a dose of 100 krads that was sufficient for disinfection, was the maximum allowable for processing of corn and pea seeds. (JPRS)

METALS, CERAMICS, AND OTHER MATERIALS

Metals and Alloys

Refer also to abstracts 23216, 23218, 23852, and 25133.

23706 (BM-RI-7116) STUDY OF COLUMBIUM AND TANTALUM ALLOYS. Babitzke, Herbert R.; Croeni, Jack G. (Bureau of Mines, Albany, Oreg. Albany Metallurgy Research Center). Apr. 1968. 16p. Bureau of Mines Free.

Results of an investigation to optimize the high-temperature properties of niobium and tantalum are reported. Niobium and tantalum were combined with selected alloying elements to achieve solid solution and dispersion strengthening. Fifty-six alloys were evaluated to determine their formability, hardness, strength at elevated temperatures, and oxidation resistance. The following six alloys showed high-temperature strength: Nb–15Hf–5W–2Zr–4Al–4Ti–2N, Nb–15Hf–5W–5Zr, Nb–15.3Ti–4.1Zr–13.7Hf; Ta–20Hf–4Al, Ta–30Hf–4Al, Ta–20Hf–5W–4Al. At 1,200°C, the niobium alloys had strength values of 40,000 psi or greater, and the tantalum alloys had strength values from 50,000 to 58,000 psi. For a 2-hour test period at 1,000°C, weight gains of only 9 and 8 mg/cm^2, respectively, were observed on oxidation testing of two alloys, Nb–15Hf–5W–2Zr–4Al–4Ti–2N and Ta–20Hf–5W–4Al. (auth)

23707 (CONF-670502) PROCEEDINGS OF THE 6TH RARE EARTH RESEARCH CONFERENCE, GATLINBURG, TENNESSEE, MAY 3–5, 1967. (Oak Ridge National Lab., Tenn. Air Force Office of Scientific Research, Arlington, Va. Directorate of Chemical Sciences). 739p. Dep. CFSTI.

Seventy-two papers and 13 abstracts of papers presented at the conference are included. Separate abstracts were prepared for 67 of the papers. The remaining 5 papers were previously abstracted for NSA. For abstract numbers of the individual papers see CONF-670502 in the Report Number Index. (M.C.G.)

For abstracts of individual papers see: 22928, 22991–23002, 23089–23091, 23708, 23726–23729, 23754–23757, 23804–23811, 23896–23898, 24023–24025, 24378–24404, and 24786.

23708 (CONF-670502–, pp 403-4) PROBLEMS AND PROGRESS IN METALLURGY OF THE RARE EARTHS. Gschneidner, Karl Jr. (Iowa State Univ. of Science and Technology, Ames).

23709 BIRTH OF THE PLUTONIUM MARKET. Ronteix, Francois; Grenier, Pierre; Dugert, Jean-Marie. Energ. Nucl. (Paris), 9: 501-7(Dec. 1967). (In French).

At a time when plutonium is beginning to be used in industry, it seems proper to attempt to outline the market which is being created for this new raw material. A comparison is made between the resources and the medium-term demands, and attempts are made to find a law for price-fixing which is also valid for the long-term. (auth)

23710 BEHAVIOR OF SUPERHEATER ALLOYS IN HIGH TEMPERATURE, HIGH PRESSURE STEAM. Lien, George E. (ed.). New York, American Society of Mechanical Engineers, 1968. 117p. $6.00. (NP-17397).

Four articles with the following titles are presented: The ASME Research Program on Properties, Scale, and Heat Transfer of Superheater Alloys; Effects of High-Temperature Steam Exposure on the Properties of Superheater Alloys; The Effect of High-Temperature Steam Corrosion Upon the Heat Transfer Through Superheater Tube Alloys; and Scale Formations on Superheater Alloys Exposed to High Temperature Steam. (D.L.C.)

23711 SMALL-ANGLE X-RAY SCATTERING. Proceedings of the Conference held at Syracuse University, June 1965. Brumberger, H. (ed.). New York, Gordon and Breach, Science Publishers, Inc., 1967. 517p. $29.50. (CONF-650629).

Twenty-six papers are included which were presented at the conference on June 24 to 26, 1965. The papers cover the state-of-the-art of small-angle x-ray scattering, and are grouped in the following categories: theory; experimental techniques; applications to macromolecular systems; applications to metals, alloys, and crystal defects; critical phenomena; and miscellaneous. A separate abstract was prepared for each of two papers selected from the applications category. Two papers previously abstracted in NSA were concerned with small-angle x-ray scattering in silica, and parasitic source of small-angle scattering. (D.L.C.)

For abstracts of individual papers see: 23817 and 23824.

23712 FUNDAMENTAL PHENOMENA IN THE MATERIALS SCIENCES. VOLUME 4. FRACTURE OF METALS, POLYMERS, AND GLASSES. Proceedings of the Fourth Symposium, Held January 31–February 1, 1966, Boston, Mass. Bonis, L. J.; Duga, J. J.; Gilman, J. J. (eds.). New York, Plenum Press, 1967. 310p. $16.00. (CONF-660102–(Vol.4)).

Information is presented concerning the various mechanisms responsible for fracture of materials. Papers are included on fracture of polycrystals, fracture in viscoelastic media, a systems-type approach to problems of fracture, viscoelasticity and plasticity considerations in the fracture of glasslike high polymers, homogeneous fatigue processes in viscoelastic polymers, the strength of inorganic glasses, fracture of ceramics, some aspects of the fracture of metallic composites, the effects of solutes on the fracture behavior of metals, and the microstructural aspects of tensile fracture. (J.R.D.)

Corrosion and Erosion

Refer also to abstracts 23003 and 23094.

23713 (BAW-3765-5) CORROSION AND HYDRIDING OF ZIRCALOY. Quarterly Technical Progress Report No. 5, October–December 31, 1967. (Babcock and Wilcox Co., Lynchburg, Va. Research and Development Div.). Feb. 1968. Contracts AT(30-1)-3765; 59-3101. 12p. (EURAEC-1951). Dep. CFSTI.

Work Performed under United States–Euratom Joint Research and Development Program.

Corrosion and hydriding of Zircaloy under heat transfer conditions to determine the quantity of hydrogen absorbed during service, and mechanical property of hydrided Zircaloy to determine the effect of hydrogen on cladding properties are the objectives of the testing. The first phase of the heat transfer corrosion and hydriding tests was previously completed. Seven specimen groups were exposed in the loop and autoclave under heat transfer and isothermal conditions simulating a pressurized water reactor environment. The exposure times varied from 360 hours to 4330 hours. The second loop test phase was initiated and modification of the water chemistry to the chemical shim environment was completed. The new test environment contains 13,000 ppM boric acid, 4 to 6 ppM potassium hydroxide, and 0.5 ppM lithium as the hydroxide. A specimen inventory in the loop for the chemical shim test was made. After about 475 hours of operation under chemical shim conditions, a previously exposed Zircaloy-2 specimen failed. All of the specimens were removed from the loop and inspected. The four unfailed specimens were returned to the loop and exposed for the planned 51 days. All of the specimens have been removed from the loop and autoclave and are currently undergoing post-test examination. The volume of data accumulated is being used to ascertain the cause of failure of the one specimen. (J.C.W.)

23714 (IN-1131, pp 91-100) AQUEOUS CORROSION TESTING OF STRUCTURAL AND CLADDING MATERIALS. (Idaho Nuclear Corp., Idaho Falls).

SAP-895 containing intermediate oxide (dispersed Al_2O_3) was tested for application as a cladding material for use in an aqueous environment. Two SAP-895 aluminum plates were tested with 1100, 2219, and 6061 aluminum plates, the Al samples being insulated from the stainless steel sample holder with Teflon. Results from the SAP-895 testing show that in an aqueous environment above ≈150°C, the finely dispersed amorphous Al_2O_3 particles on the sample surface hydrate, resulting in particle swelling. Testing of stainless steel was carried out to extend temperatures and chloride contents beyond the conditions of the proposed heat exchanger parameters to determine if a new threshold temperature would be crossed which would greatly increase the incidence of stress corrosion cracking. Results indicate that 316 stainless steel can be protected up to 215°C in water containing 500 ppM chlorides by the phosphate additions. (J.C.W.)

23715 (NAA-SR-Memo-9329) EXPLORATORY INVESTIGATION OF INTERACTION BETWEEN METALLIC ELEMENTS, CARBON, AND OXYGEN IN STAINLESS STEEL–SODIUM SYSTEMS. Johnson, D. L. (Atomics International, Canoga Park, Calif.). Dec. 31, 1963. 41p. Dep. CFSTI.

Experiments were conducted to investigate various aspects of carbon transfer in sodium systems. Capsule tests to determine if C transfers to iron in low-C Na at austenite temperatures were not definitive due to interaction with the capsule. C-saturated Na carburized iron at austenite temperature despite capsule interaction. Carbon was removed from low-C sodium (>50 ppM C) by chromium (1450°F) or sheathed calcium (1675°F) additions. Sheathed barium tests were inconclusive. Comparison of alu-

minized 304 stainless steel capsules and tantalum-lined capsules indicated that Ta-lined capsules were essentially inert to C-saturated Na, while aluminized 304 stainless steel capsules did gain some C. Ta-lined capsules are recommended for precision C balances. Small amounts of C were added in precise amounts to Na systems by exposing plain C steel of known C content to low-C Na at 1200°F. Decarburization of the steel readily occurred, and analysis after exposure was employed to determine the amount of C dissolved by the Na. The effect of O_2 on carburization was pronounced at 1000°F and 1100°F, but was not nearly so significant at 1200°F. Oxygen-saturated Na carburized 304 stainless steel significantly (~3% C_s) at 1000°F, while low O_2 Na did not carburize the 304 stainless steel. The surface of carbon-saturated 304 stainless steel decarburized in 1200°F Na, but did not decarburize significantly at 1000°F. (auth)

23716 (RD/B/N-1006) HIGH TEMPERATURE OXIDATION OF AN Fe-15Cr-4Al-1Y ALLOY IN CARBON DIOXIDE. Francis, J. M.; Jutson, J. A. (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.). Feb. 1968. 10p. (JNPC/FEWP(CPSG)P-(67)32). Dep.

The structure and composition of thin oxide films formed during high temperature oxidation of an Fe-15Cr-4Al-1Y alloy in CO_2 are reported. Over the exposure period 0.1 to 1000 hr, the rate controlling step is attributed to self-diffusion of Al^{3+} in Al_2O_3. No other phase contributes significantly to the oxidation behavior of this alloy, apart from Y_2O_3, which apparently enhances scale adhesion. (auth)

23717 HIGH TEMPERATURE COMPATIBILITY OF REFRACTORY METALS WITH SCANDIUM OXIDE. Dubok, V. A.; Tyutkalo, L. I. (Inst. of Problems in Studies of Materials, Kiev). Porosh. Met., Akad. Nauk Ukr. SSR, No. 1, 83-7(Jan. 1968). (In Russian).

The high-temperature compatability of the refractory metals Ta, Mo, W with scandium oxide was experimentally studied. The thermodynamic calculations were made from the free energy changes during exchange reactions between Sc_2O_3, Y_2O_3, and Ta, Nb, V, W, and Mo. The results of the experiments and theoretical calculations testify to the absence of interaction between the oxide and metal. (tr-auth)

23718 INTERFACIAL CORROSION IN NUCLEAR REACTORS. Raviv, S.; Rabinovitz, E.; Malkiely, S.; Gabriel, I. (Israel Atomic Energy Commission, Negev). Energ. Nucl. (Paris), 10: 16-21 (Jan.-Feb. 1968). (In French).

From the theoretical point of view, corrosion may be considered as a succession of adsorption and desorption phenomena of the elements forming the double layer on the metal ion of the crystal lattice of the surface; these phenomena following the Freundlich and Langmuir isotherms. Work was done for the purpose of helping to clarify the interfacial reactions of the constituents which are the cause of the corrosion phenomena. The behavior of some systems with two or three electrodes (uranium/aluminium, uranium/stainless steel, Al/Al-Zn/stainless steel) used in the nuclear industry with and without cathodic polarization, in nitric and aqueous media was studied. (auth)

23719 CORROSION PRODUCT OF THE TANTALUM-INTERSTITIAL OXYGEN-POTASSIUM SYSTEM AT 1800°F (982°C). Hickam, C. W. Jr. (Lewis Research Center, Cleveland). J. Less-Common Metals, 14: 315-22(Mar. 1968).

The isolation and identification of the corrosion product formed by the exposure of oxygen-doped tantalum to potassium are described. The corrosion of tantalum by liquid potassium appears to be quantitatively dependent on the oxygen impurity content and to occur by the formation of a ternary oxide. When tantalum containing oxygen in the range 1600 to 3800 ppM is exposed to potassium at 1800°F, depletion of oxygen from tantalum occurs and the hygroscopic potassium tantalate, K_3TaO_4, is isolated as the reaction product. Indications are that under the test conditions, the dissolution of tantalum is quantitatively governed by the equation $3K + Ta + 4O_{(Ta)} \rightarrow K_3TaO_{4(K)}$. These results imply that the total amount of oxygen-effect corrosion can be predicted when the total amount of interstitial oxygen in tantalum is known (i.e., oxygen in solution in the metal initially, plus oxygen that enters the metal from the environment during the life of the system). Since oxygen-effect corrosion is the most serious type of corrosion encountered by tantalum alloys in contact with potassium at elevated temperatures, the present results are significant for the design and operation of advanced space power systems. (auth)

23720 USE OF THE NUCLEAR REACTION $^{16}O(d,p)^{17}O$ TO STUDY OXYGEN DIFFUSION IN SOLIDS AND ITS APPLICATION TO ZIRCONIUM. Amsel, G. (Ecole Normale Superieure, Paris); Beranger, G.; de Gelas, B.; Lacombe, P. J. Appl. Phys., 39: 2246-55(Apr. 1968).

A method for the determination of oxygen diffusion in metals, making use of the $^{16}O(d,p)^{17}O$ nuclear reaction, is described in the case of oxygen dissolved in zirconium after oxidation. Energy spectra of protons obtained experimentally have been compared with spectra calculated on a theoretical basis. The oxygen-concentration profile in zirconium and in a zirconium copper alloy, after an oxidizing treatment at 750°C, was measured. The results are compared with microhardness measurements and show that the microhardness oxygen-content relation is not linear. Furthermore, the determined oxygen-concentration profile suggests that the diffusion coefficient of oxygen in zirconium is concentration dependent. (auth)

23721 SOME CHARACTERISTICS OF THE MECHANISM OF OXIDATION OF TITANIUM AND ZIRCONIUM. Lainer, D. I.; Bai, A. S. Tr. Gos. Nauch.-Issled. Proekt. Inst. Splavov Obrab. Tsvet. Metal, No. 24, 93-5(1965). (In Russian).

The oxidation of Zr at 1000°C. in air and in water vapors was studied. After oxidation in air for 30 min, steam was fed into the system and the oxidation continued for 1 hr. Near the external surface the microstructure of the scale did not change compared with oxidation in air. A new layer, consisting of fine acicular crystals typical for oxidation in water vapors, was formed below this layer. This indicates that the oxidation of Zr is due to the diffusion of O_2 to the surface of the metal and that the front of recrystallization is at the metal/oxide interface. Previous investigations showed that during the oxidation of Ti the diffusion of Ti through the scale plays an important role. (Rev. Metal Lit.)

23722 RECENT RESULTS TO THE PROBLEM OF PREOXIDATION AND THE HYDROGEN ABSORPTION OF ZIRCALOY-ALLOYS IN WATER AND STEAM. Debray, W.; Stieding, L. (Siemens AG, Erlangen, Ger.). pp 85-98 of Development of Light Water Reactors in the Community. Brussels, Euratom, 1967. (In German).

See EUR-3561; CONF-661134.

Materials and materials treatment procedures for experiments on preoxidation of and hydrogen absorption by Zircaloy alloys are described. Corrosion data are tabulated; measurement techniques are outlined. Temperature and atmospheric effects are tabulated. 15 references. (M.L.S.)

23723 EFFECT OF THE Ca CONTENT IN Na ON THE CORROSION OF V AND THE ALLOY V-10 WT PERCENT Ti. Schneider, H.; Borgstedt, H. U.; Drechsler, G.; Frees, G. (Kernforschungszentrum, Karlsruhe, Ger. Institut fuer Material- und Festkoerperforschung, Karlsruhe, Ger. Institut fuer Reaktorbauelemente, Karlsruhe, Ger.). J. Nucl. Mater., 25: 347-9(1968). (In German).

Loop studies were made on the corrosion effect of Na on unalloyed V and the alloy of V with 10% Ti. The oxide layers of the corroded samples were analyzed qualitatively and quantitatively for Ca. The results show that the Ca is enriched from 3 to 5% in the corrosion layers with respect to the purified Na. The enrichment occurs in the outermost layers of the reaction zone of the V alloy. If the Ca content of the Na was reduced by gettering, the weight of the corrosion layers was greatly reduced. Ca traces in the Na stimulate the corrosion phenomena in V and its alloys with Ti in flowing Na. (J.S.R.)

23724 MONITORING CORROSION RATES BY MEANS OF RADIOACTIVE TRACERS. Raifsnider, Philip J.; Guinn, Vincent P. (to Shell Oil Co). U. S. Patent 3,348,052. Oct. 17, 1967. Filed June 24, 1965.

A method is described for radioactive monitoring of materials corrosion in inaccessible locations such as in oil well production or drilling strings. Flush mounted metal coupons having the same corrosion characteristics as the rest of the pipe, and containing ^{59}Co are inserted at intervals in the string. The specimens are then subjected to a high neutron flux to activate to ^{60}Co. The rate of corrosion is monitored by periodically or continuously detecting the counting rate of ^{60}Co in the effluent pumped through the pumping string. Since the specimen is designed to corrode at the same rate as the steel in the production string it indicates the rate of corrosion and serves as control for injection of corrosion inhibitors. (P.G.C.)

Preparation and Fabrication

Refer also to abstracts 23127 and 25156.

23725 (BM-RI-7118) TUNGSTEN WHISKERS BY VAPOR-PHASE GROWTH. Starliper, A. G.; Kenworthy, H. (Bureau of Mines, Rolla, Mo. Rolla Metallurgy Research Center). Apr. 1968. 13p. Bureau of Mines Free.

Laboratory studies were made to produce whiskers of tungsten over a wide range of operating temperatures. Hydrogen reduction

of tungsten hexachloride in a vacuum furnace at 2,700 to 3,300°C yielded a small quantity of tungsten whiskers, provided a low degree of supersaturation was maintained. Direct measurements of 3,000,000 to 4,000,000 psi were obtained for the ultimate tensile strengths of individual whiskers averaging 3 to 4 microns in diameter with average aspect ratios of 1,000. This compares with strengths of 300,000 to 400,000 psi for 13-micron-diameter commercial filaments. (auth)

23726 (CONF-670502–, pp 1-6) RARE EARTH USES. Kremers, Howard E. (American Potash and Chemical Corp., New York).

The rare-earth-producing industry has gone through several cycles of end-use patterns, and these are reviewed as they relate to technical progress made by industry. (auth)

23727 (CONF-670502–, pp 653-64c) CHEMICAL ASPECTS OF INDUSTRIAL PREPARATION OF THE RARE EARTH METALS. Moriarty, J. L. (Lunex Co., Pleasant Valley, Iowa).

Experience with the industrial process chemistry involved in producing rare earth metals is reviewed. Fluoride and chloride preparatory methods are discussed along with tabular presentations of some physical property data. Metallothermic reduction techniques as applied to both processes are shown. Also a comparison of representative metal microstructures and analyses is made. Employing the chloride process oxide conversions in excess of 97% and yields of recovered metal from 77 to 86% theoretical are expected. Average typical spectrographic and gas analyses indicate that a final product purity of 99.9+% is common for the metals prepared. The thermodynamic and vapor pressure characteristics of several of the rare earth permits direct reduction of their oxide to metal. High-purity metals behave nicely and can be readily cast, rolled, and machined under the appropriate conditions. In producing the rare earth elements on a commercial scale numerous factors such as optimum purity, availability, marketability, demand, economics, and equipment requirements must be carefully considered. (auth)

23728 (CONF-670502–, pp 714-27) DIRECT ELECTROLYSIS OF RARE-EARTH OXIDES TO METALS AND ALLOYS IN FLUORIDE MELTS. Morrice, E.; Shedd, E. S.; Henrie, T. A. (Bureau of Mines, Reno, Nev. Reno Metallurgy Research Center).

Techniques developed by the Federal Bureau of Mines for the preparation of high-purity rare earth metals and their alloys by electrolysis of the oxides in fluoride media are discussed. Individual cerium, lanthanum, neodymium, praseodymium, dysprosium, gadolinium, and yttrium metals, as well as the mixture "didymium," and specific alloy compositions of these metals and samarium with iron, nickel, chromium, and cobalt, were prepared. Individual metals were electrodeposited in the liquid state on tungsten or molybdenum cathodes. Alloys were prepared by electrodepositing the rare earth metal on a consumable base metal cathode at a temperature above the melting point of the eutectic formed between the rare earth element and the cathode material. Cells for electrowinning metal products in gram and pound quantities, along with methods for the continuous electrowinning of cerium and lanthanum, are described. (auth)

23729 (CONF-670502–, pp 728-39) COMMERCIAL PRODUCTION OF RARE EARTH METALS BY FUSED SALT ELECTROLYSIS. Hirschhorn, I. S. (Ronson Metals Corp., Newark, N. J.).

The commercial production of rare earth metals by fused-salt electrolytic methods is described. These methods are used to make mischmetal, cerium, lanthanum, and didymium (Nd + Pr). The feed materials consist essentially of anhydrous chlorides of the metal to be produced, augmented by additions of non-rare earth salts to yield an electrolyte with satisfactory properties for reduction. The rare earths are derived either from monazite or from bastnasite ores. The anhydrous chlorides are manufactured from the hydrated chlorides by methods that minimize oxidation or hydrolysis. Alternatively, anhydrous chlorides may be used, which result from the direct chlorination of rare earth ores by the Goldschmidt process. These are particularly suitable for electrolysis due to their very low oxychloride content. Fluorides and oxides of the rare earths are produced by wet chemical methods to provide the relatively small quantities of these compounds now used for commercial fused salt electrolysis. Reduction cells are constructed mainly from ceramics, graphite, or iron. The advantages and disadvantages of these types of cells are described together with the typical products which result from their use. A resumé of the current uses of these metals is presented with reference to recent trends in the industrial applications of the rare earth metals. (auth)

23730 (DLR-MITT-66-07, pp 69-72) HOCHTEMPERATURTESTS AN MIT WOLFRAM UMHUELLTEN UO_2-Mo-CERMETS FUER THERMIONISCHE REAKTORBRENNELEMENTE. (High-Temperature Tests with Tungsten Clad UO_2-Mo Cermets for Thermionic Reactor Fuel Elements). Schuster, K. (Battelle Institut e. V., Frankfurt am Main (West Germany)). (In German).

UO_2– Mo cermets of three different types filled with W were heated in vacuum to 1,800°C. After heating the sample surface was examined microscopically and the form stability was tested. The mass of evaporated material was determined, the α activity of the sample surface was measured, and microprobe pictures were made of the surface. The results show that the Mo present as matrix material in cermet diffused rapidly in the external W layer. With increasing heating time the surface of the sample is crystallized more and more. W coatings are dissolved almost completely in the Mo of the matrix. Only UO_2 is evaporated from the sample. The external W layer is a much better diffusion barrier for UO_2 than the Mo of the matrix. (J.S.R.)

23731 (USBM-RC-1274) AN EVALUATION OF W-25Re PRODUCED BY BOTH ARC-MELTING AND POWDER METALLURGY. Period Covered: September 1, 1964–July 31, 1967. Lowery, R. R.; Asai, G. (Bureau of Mines, Albany, Oreg. Albany Metallurgy Research Center). Jan. 1968. Contract AT(11-1)-599. 74p. Dep. CFSTI.

An evaluation of tungsten-25 weight percent rhenium alloy processed by both powder-metallurgy (PM) and arc-melting (AM) techniques was accomplished. Methods of consolidation, fabrication, and testing are discussed. Extrusion was used as the primary breakdown process for the PM and AM billets. Sheet bar extrusions, 2.54 cm by 5.08 cm in cross section, were conditioned and rolled to 0.15 cm-thick sheet. Bend tests were made upon the sheet to determine ductile-to-brittle transition temperatures (DBTT). The AM sheet was superior to PM sheet in ductility. Recrystallized AM sheet exhibited a DBTT of 185°C in a 4t bend, whereas, the corresponding temperature for PM sheet was 380°C. Tensile properties of recrystallized AM sheet were determined from 25 to 2,500°C. Creep-rupture data at 1,650°C and 2,200°C were collected up to 1,000 hours. The PM sheet was inferior to the AM sheet in both ductility and rupture life. An examination was made of electron-beam weld zones in both sheet products which indicated porosity was more extensive in the weld zones of the PM sheet. Electron microscopy was used to view fractures in both bend and weld specimens. Porosity was found in the PM sheet in both cases. (auth)

23732 INVESTIGATION OF OBTAINING CONIDITIONS AND SOME PHYSICAL PROPERTIES OF THE ALLOYS OF THE WB–LaB_6 SYSTEM. Lapshov, Yu. K.; Podchernyaeva, I. A.; Samsonov, G. V.; Terekhov, V. P.; Fomenko, V. S. Porosh. Met., Akad. Nauk Ukr. SSR, No. 1, 68-76(Jan. 1968). (In Russian).

The conditions of synthesizing and some of the physical properties, as well as the phase composition of the alloys of the WB–LaB_6 system (1 to 50 mol % of LaB_6) are reported. On the basis of concentration dependences of microhardness and electric resistance of the alloys a supposition is made of the partial dissolution of La in WB for the composition containing more than 5 mol % of LaB_6. The investigation of thermoemission properties showed that the additive of lanthanum hexaboride (5 and 10 mol %) to tungsten boride does not change essentially the work function of the latter at 1850 to 1900°K. At this temperature a sharp activation of the alloys takes place up to the work function minimum stable value 3.50 eV. (tr-auth)

23733 CONTRIBUTION TO THE THERMAL DISSOCIATION OF THORIUM TETRAIODIDE. Gerlach, J.; Pawlek, F.; Probst, H. (Technische Univ., Berlin). J. Less-Common Metals, 14: 355-66(Mar, 1968). (In German).

The speed of operation of the iodide process as used in the refining of thorium has been studied in relation to its dependence on the temperature of the crude metal, the deposition temperature, and the pressure of ThI_4 vapor. The speed of transport of the thorium showed a maximum at about 0.06 torr pressure of ThI_4 vapor. The occurrence of this transport maximum can be attributed to the interplay of the two different transport reactions at the deposition wire. According to the total pressure, the speed of the transport is determined by the phase-boundary reactions on the hot wire or the diffusion/convection in the gas phase. (auth)

23734 ELECTRON-BEAM UNIT FOR METAL MELTING. Popov, V. K.; Demin, E. P. Elektron. Obrab. Mater., No. 2, 77-84(1966). (In Russian).

A 60-kW electron-beam unit for vacuum remelting of refractory metals has been used for industrial production of ingots, up to 70 mm in diameter and up to 300 mm long, of titanium, niobium, molybdenum, zirconium, tantalum and their alloys. Electron-beam vacuum remelting increased the ductility and elongation and decreased the hardness of tantalum and niobium. For example, the hardness of niobium decreased from 85 to 65 kg/mm^2 after double remelting and to 52 kg/mm^2 after triple and fourfold remelting. Because of the formaton of very hard and brittle MoC and Mo_2C carbides in the reaction of molybdenum with oil vapor, production

of ductile molybdenum requires the development of melting units with vacuum or diffusion pumps which use no oil or are equipped with special traps for reliable protection of the melting chamber from the entry of oil vapors. (ATD)

23735 PRESS-FORMING PROPERTIES AND BENDING TESTS OF MOLYBDENUM SHEET. Wusatowski, Zygmunt; Starzyczny, Gerald. Wiad. Hutn., No. 12, 367-72(1966). (In Polish).

Tests aimed at production of molybdenum sheet for pressforming without brittleness and anisotropy, were performed by selecting proper forging, hot-rolling, and cold-rolling conditions. Molybdenum sheet was used as a standard; Erichsen and Swift cupping tests were employed. The material exhibited a deep drawing ratio of 2:1 (height to diameter), and a 730°C maximum annealing temperature. Prolonged annealing and quenching temperatures above 1000°C are not recommended because of resultant grain growth (recrystallization) and embrittlement. (ATD)

23736 STRUCTURE OF W FILMS PREPARED BY TRIODE SPUTTERING AT LOW PRESSURE AND ENERGY. Sella, Claude; Coppens, Rita (Centre National de la Recherche Scientifique, Bellevue, France. Univ., Louvain, Belgium). Compt. Rend., Ser. A and B, 265: 410-3(Aug. 16, 1967). (In French).

The structure of W films sputtered under 10^{-3} torr by Ar ions at 1,000 V and condensed with a velocity of 120 Å/min on NaCl cleavages was studied as a function of the substrate temperature. Up to 190°C the films are amorphous; between 200 and 350°C they have a cubic centered structure oriented by epitaxy whereas in the range from 400 to 450°C the epitaxy structure becomes face centered cubic. The effects of other parameters such as sputtering velocity, pressure, and film thickness were also studied. (tr-auth)

23737 PREPARATION OF FINE RECRYSTALLIZED TUNGSTEN WIRE FOR TRANSMISSION ELECTRON MICROSCOPY. Koch, E. F.; Walter, J. L. (General Electric Co., Schenectady, N. Y.). Trans. Met. Soc. AIME, 242: 157-60(Jan. 1968).

As-drawn, recrystallized W wire samples were prepared for transmission electron microscopy to study the properties and structure of W wires used for lamp filaments. Fine W wire was wound on a 0.060 in.-thick W plate and annealed at 1800 to 2000°C from 1 to 3 hr at 10^{-6} and 10^{-7} torr. After the sheet of wires was separated from the W plate, the sheet was encapsulated in epoxy and polished and the structure of the wire was studied. (F.S.)

23738 HETEROEPITAXIAL GROWTH OF MOLYBDENUM THIN FILMS ON INSULATING SUBSTRATES. Manasevit, H. M. (North American Rockwell Corp., Anaheim, Calif.); Morritz, F. L.; Forbes, D. H. Trans. Met. Soc. AIME, 242: 75-8(Jan. 1968).

Single-crystal thin films of molybdenum have been grown by the pyrolytic decomposition of molybdenum hexafluoride in a hydrogen ambient on various insulating substrates at 650 to 900°C. Single-crystal discs of various orientations of magnesium aluminate spinel, α aluminum oxide, magnesium oxide, and the natural facets of beryllium oxide were all observed to exert epitaxial control on the depositing film. Determinations of the crystallographic relationships existing between film and substrates have been made, using x-ray diffraction three-circle goniometry and Laue back-reflection techniques. Using these data, crystallographic overlays have been constructed which suggest a possible interfacial geometry on the basis of a match between metal deposit atoms and metal ion sites in the substrate. (auth)

23739 COMPOUND U_2Ru_3. Berndt, A. F. (Univ. of Missouri, St. Louis); Dwight, A. E. Trans. Met. Soc. AIME, 242: 340-1(Feb. 1968).

The crystal structure and density of U_2Ru_3 which is formed by a peritectoid transformation at 1025°C was studied. The alloy was prepared by arc melting electrolytic uranium and ruthenium of 99.9% purity on a water-cooled copper hearth under an argon atmosphere. (F.S.)

23740 JOINING DISSIMILAR METALS BY GAS TUNGSTEN-ARC BRAZE-WELDING. Solomon, D. F. (Univ. of Michigan, Ann Arbor). Weld. J. (N. Y.), 47: 181-4; 189-91(Mar. 1968).

Methods and equipment for joining such dissimilar metals as W-stainless steel, Cu-W, Mo-stainless steel, and W-carbon steel are described. Filler metals, selected by a study of the binary phase diagrams of the constituents, with a liquidus temperature lower than that of the base metals are used to wet the metals being joined. The process combines the advantages of reducing atmosphere brazing with the simplicity of shielded arc welding and is particularly adapted to joining aerospace structures, electron tubes, and vacuum equipment. (P.G.C.)

23741 BRAZING OF NICKEL-CHROMIUM ALLOY 718. Kirby, R. S.; Hanks, G. S. (Los Alamos Scientific Lab., N. Mex.). Weld. J. (N. Y.), 47: 97s-105s(Mar. 1968). (LA-DC-8938).

Complex tubular structural assemblies, of Inconel-718, for the Phoebus-2A reactor were fabricated by brazing and gas-shielded-arc welding. Filler metal was an alloy of 82 Au-18 Ni having a flow point of 1800°F. Surfaces to be brazed were preplated with 0.0005 in. of Ni to ensure a good flow of filler metal. Brazing was done in an A atmosphere of <1 ppM H_2O and <2 ppM O_2. Assemblies had a tensile strength >200 ksi and a yield strength of >200 ksi. (P.G.C.)

23742 NICKEL–BERYLLIUM ALLOY AND METHOD OF HEAT TREATING SAME. Wikle, Keith G. (to Brush Beryllium Co.). U. S. Patent 3,343,949. Sept. 26, 1967. Filed Mar. 1, 1965.

Nickel-base Be alloys containing uniformly dispersed graphite nodules were developed which were more easily machined than commercial alloys of the same composition and maintained comparable tensile strength, hardness, and other properties. Dispersion of carbon in nodular form throughout the alloy was accomplished by addition of Ca, Ce, La, Mg, or Nd to the melt. (P.G.C.)

23743 TERNARY URANIUM ALLOYS CONTAINING MOLYBDENUM WITH NIOBIUM OR ZIRCONIUM FOR USE WITH NUCLEAR REACTORS. Fizzotti, Carlo; Colabianchi, Guglielmo; Dalmastri, Benito; Masperoni, Alberto (to Comitato Nazionale per l'Energia Nucleare). U. S. Patent 3,343,947. Sept. 26, 1967. Priority date Jan. 29, 1965, Italy.

Specifications are given for preparation and heat treatment of U-base-Mo-Nb, and U-base Mo–Nb–Zr alloys for reactor fuels. The alloys are stable, fine grained, and free from preferential orientation and distortion as cast. (P.G.C.)

23744 TITANIUM BASE ALLOY. Peebles, Roger E. (to Titanium Metals Corp. of America). U. S. Patent 3,343,951. Sept. 26, 1967. Filed Mar. 1, 1965.

Alpha-type Ti base alloys containing Al, Mo, Sn, and Zr were developed which have high strength-to weight ratios, stability, creep resistance, and high strength at elevated temperatures. The alloys maintain ductility and weldability characteristics. (P.G.C.)

23745 METHOD OF BONDING A BORON NITRIDE BODY TO A REFRACTORY METAL. Rively, Clair, M.; Livera, Phillip A. (to Westinghouse Electric Corp.). U. S. Patent 3,344,505. Oct. 3, 1967. Filed Sept. 22, 1964.

Techniques and equipment for bonding Mo, Ta, or W to BN by flash evaporation of Al are described. (P.G.C.)

23746 PROCESS FOR PRODUCING CLADDED FUEL ELEMENTS. Stohr, Jacques Andre (to Commissariat a l'Energie Atomique). U. S. Patent 3,344,508. Oct. 3, 1967. Priority date Feb. 20, 1963, France.

Composite billets or blooms of Zr clad U–Zr elements containing 2 to 8% U are co-extruded or co-rolled at room temperature to 400°C to form round bars, tubes, or plates after previously forming a diffusion bond between core and cladding by hydrostatic pressure or by thermopneumatic means at 750 to 950°C. The method eliminates necessity for preheating at high temperatures in controlled atmospheres and use of apparatus for welding and sealing jackets. (P.G.C.)

23747 A PROCESS FOR WELDING COMPOSITE METAL-OXIDE MATERIALS SUCH AS SINTERED ALUMINIUM POWDER (SAP). Beghi, Giorgio; Musso, Guiseppe (to European Atomic Energy Community). British Patent 1,108,018. Mar. 27, 1968. Filed July 31, 1964.

Welding of two members, one a composite metal-oxide material like SAP or other cermet, the other a metal, alloy, or of the same or other composite metal-oxide material is accomplished by heating one member to fusion or to a softening temperature and gently immersing the second member into the central area of the fused zone for 5 to 6 min. The junction so obtained is cooled in place and machined. (P.G.C.)

23748 PLUTONIUM ETCHING. Kolodney, Morris (to United States Atomic Energy Commission). U. S. Patent 3,380,865. Apr. 30, 1968.

A method for etching the surface of a plutonium article in order to obtain a surface that is easily plated was developed. The article is immersed in an aqueous sulfuric acid solution containing a substantial concentration of ammonium sulfate. (AEC)

23749 ELECTROLYTIC PROCESS FOR CLEANING PLUTONIUM METAL. Kolodney, Morris (to United States Atomic Energy Commission). U. S. Patent 3,377,257. Apr. 9, 1968.

A process for cleaning plutonium which comprises making the surface anodic in an electrolyte consisting of concentrated orthophosphoric acid and ethylene glycol was developed. (AEC)

23750 PURIFICATION OF ELEMENTAL BORON. Weil, Walter M. British Patent 1,108,290. Apr. 3, 1968. Priority date Feb. 1, 1966, United States.

A method is described for the purification of elemental B, more specifically for crude, elemental, powdered B containing, as a principal impurity, boron suboxides and as a secondary impurity, carbon. A chamber containing the B in a restricted heating zone is evacuated to lower the pressure within the chamber into a range of 0.1 to 200 μ of Hg, absolute pressure. Heat is generated within the chamber and is concentrated on the B to raise its temperature within the range of 1800 to 2100°C for vaporizing the boron suboxides along with the non-condensable gaseous distillation products. Cooler zones are maintained within the chamber about the heating zone to condense condensable distillation products. The noncondensable distillation products are drawn away from the cooler zones and out of the chamber by continuing the evacuation during the heating step. (B.L.M.)

23751 POLONIUM RECOVERY. (to United States Atomic Energy Commission). British Patent 1,107,954. Mar. 27, 1968. Priority date Mar. 26, 1965, United States.

Polonium was recovered from a solution of Po in Bi metal by adding Ce metal and melting. Cerium bismuthide precipitates and Po is carried by the cerium bismuthide precipitate or coprecipitated with it. The Po-containing cerium bismuthide is lighter than the Bi and floats on top. It can be separated from the Bi by skimming or by cropping it off after solidification of the entire mass. The quantity of Ce added should be about 0.7 to 2 wt %, an amount that will dissolve quickly at 500 to 600°C. (B.L.M.)

Properties Evaluations

Refer also to abstracts 23194, 23256, 23363, 23725, 23895, 24378, 24379, 24389, 24392, 24394, 24395, 24398–24404, 24408, 24479, and 25172.

23752 (AERE-M/R-1746) WETTING PROPERTIES OF SOLID OXIDES AND CARBIDES BY LIQUID METALS. Livey, D. T.; Murray, P. (Atomic Energy Research Establishment, Harwell (England)). Sept. 16, 1955. 44p. Dep. CFSTI. UK.

Experiments have been carried out on the wetting properties of solid oxides and carbides by liquid metals and an estimation has been made of the surface energy of UO_2 and of the refractory monocarbides. The results indicate that, in the absence of chemical reaction, oxide surfaces are only wetted by metals of low atomic number. The suggestion is made that this is due to an attraction existing between the positive nucleus of the metal and the negatively charged anions of the oxide surface. Conversely nonwetting by metals of higher atomic number is due to repulsion between the negative surface and the electron cloud of the metal. Carbides are more readily wetted by liquid metals because of the different nature of the carbide surface, this being dominated by the metal atoms and not as in oxides, by negative anions. Carbides of high surface energy have then a low interfacial tension with liquid metals and hence good wetting properties. For the application of liquid metals to nuclear reactors in which refractory uranium compounds are suspended in the liquid metal, wetting is essential. Uranium oxide (UO_2) and uranium carbide are readily wetted by liquid sodium at 400°C. Bismuth, of special importance because of its low capture cross section, is non-wetting to oxide and carbide. The addition of 0.3% nickel lowers the wetting temperature in the Bi ~ UC system in vacuo from 700 to 580°C. Coating of the carbide particles with silver also promotes wetting by bismuth. (auth)

23753 (BARC-308) THE CREEP BEHAVIOUR OF Zr–0.5 WT PERCENT Nb–1.0 WT PERCENT Cr ALLOY. Ray, S.; Mehta, M. L. (Bhabha Atomic Research Centre, Bombay (India)). 1967. 12p. Dep.

The creep curves at stresses of 30,000 to 80,000 psi and temperatures of 300 to 470°C are given as graphs and tables. Creep data of heat-treated Zr–2.5 wt % Nb alloy are also given for comparison. An examination of the Zr–0.5 wt % Nb–1.0 wt % Cr alloy after creep testing at 300 to 470°C for 1000 hr or more, shows that the alloy has good oxidation resistance. (D.L.C.)

23754 (CONF-670502–, pp 522-33) ELASTIC MODULI OF Gd METAL. Fisher, E. S.; Dever, D. (Argonne National Lab., Ill.).

The elastic moduli of Gd single crystals were measured over the temperature range from 4 to 923°K. The results indicate that some degree of magnetic ordering exists between T_c and 330°K. A sharp transition is indicated at 286°K for compressional modes and at 289°K for shear modes. It is suggested that a change in direction of the magnetic moments occurs abruptly at 218°K. The Debye θ calculated from the 4°K data is 181.5°K. This, together with the Debye θ calculated for Er (θ = 191°K) suggests that the Debye θ of the trivalent rare earth metals is linearly related to the atomic weights. The anisotropy ratio, $A = c_{44}/c_{66}$, increases with temperature in the paramagnetic phase as expected for hcp metals that transform to the bcc structure at high temperatures. (auth)

23755 (CONF-670502–, pp 534-45) THE HEAT CAPACITY OF SCANDIUM FROM 1 TO 23°K. Flowtow, Howard E.; Osborne, Darrell W. (Argonne National Lab., Ill.).

The heat capacity of a well-characterized, polycrystalline scandium sample was measured from 0.9 to 23°K. The results are in reasonable agreement with previous measurements below 4°K, except that a small anomalous addendum to the heat capacity was detected. This anomaly follows a T^{-2} dependence down to 2.9°K, rises to a maximum of about 1.3 mJ deg^{-1} (g at. Sc)$^{-1}$ near 1.2°K, and has an associated entropy of 3.2 mJ deg^{-1} (g at. Sc)$^{-1}$. It is believed to be due to small concentrations of magnetic impurities found in the sample. An evaluation of the results from 2.9 to 8.4°K gave $\gamma = 10.66 \pm 0.10$ mJ deg^{-2} (g at.)$^{-1}$ and $\theta = 359.5 \pm 4.2$°K. A table of smoothed heat capacities and thermodynamic functions for scandium at selected temperatures between 5 and 298.15°K is presented. (auth)

23756 (CONF-670502–, pp 546-55) CRYSTAL FIELD HEAT CAPACITIES OF $PrNi_2$ AND PrBi. Dixon, M.; Aoyagi, M.; Craig, R. S.; Wallace, W. E. (Pittsburgh Univ., Pa. Dept. of Chemistry).

Heat capacities of $PrNi_2$, $CeNi_2$, PrBi, and LaBi were measured from 1.5 to 300°K. The first two compounds are cubic Laves phases while the latter two have the NaCl structure. One of the objectives of this investigation was to evaluate the crystal field heat capacity of $PrNi_2$. The heat capacity of $CeNi_2$ was measured in order to obtain an estimate of the vibrational contribution, the difference in heat capacity between $CeNi_2$ and $PrNi_2$ being taken as the crystal field heat capacity of the latter. The excess heat capacity of $PrNi_2$ was observed as a broad maximum at about 12°K. The excess heat capacity below 30°K was considerably larger than expected from the crystal field contribution. The heat capacity of $CeNi_2$ exhibited an anomaly in the liquid helium temperature range. It is suggested that the anomaly results from a small population of trivalent Ce ions, which begin to order at about 2.5°K. The crystal field heat capacity of PrBi was found by taking the difference in heat capacity between PrBi and LaBi. The crystal field heat capacity thus found appeared as a somewhat broader anomaly than predicted from the limiting susceptibility. Measurements on PrBi showed some other interesting features. The data on elemental Pr obtained by Lounasmaa when plotted as C/T versus T^2 showed a kink in the curve at about 3.5°K and a minimum at about 1.5°K. These two effects also showed up in the PrBi data, the kink in the C/T versus T^2 curve appearing at about 3.6°K and the minimum at about 2°K. It is suggested that the anomalous effects in both Pr and PrBi are due to a small population of quadrivalent Pr ions, which order at low temperatures. (auth)

23757 (CONF-670502–, pp 568-80) ANALYSES OF LOW-TEMPERATURE HEAT CAPACITIES OF THE RARE-EARTH METALS. Morrison, J. A.; Newsham, D. M. T. (National Research Council of Canada, Ottawa (Ontario)).

Low-temperature heat-capacity data for rare earth metals were reanalyzed and somewhat different results were obtained for individual contributions to the total heat capacity of several of the metals. Since the proportions of the different contributions vary from metal to metal, and with temperature, the advantages of a graphical analysis as opposed to a standardized (computer) analysis are stressed. For each metal considered, the analysis gives the coefficient of the electronic contribution, and the coefficient of the leading term in the series expansion for the nuclear-hyperfine contribution, to an accuracy comparable to that of the experiments (a few percent at worst). For Yb and Lu, estimates of the lattice contributions were obtained. For only four of the metals (Pr, Nd, Eu, and Tm) is the magnitude of the magnetic contribution to the heat capacity large enough for its form to be determined. For these metals, the magnetic heat capacity seems to have an exponential temperature dependence. (auth)

23758 (EUR-3899) EQUIPMENT FOR INVESTIGATING THE THERMAL STRESS FATIGUE BEHAVIOUR OF SAP. van Enk, R. H. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). 1968. 32p. Dep.

A detailed description is presented of the equipment for investigating the thermal stress fatigue behavior of SAP (10% oxide). It is intended to use this material as a pressure tube in the ORGEL-reactor. The problems raised by the investigation program and their solutions are surveyed (e.g., the temperature measurement of the thin-walled SAP test specimen). In addition, the results of the first test series are presented. (auth)

23759 (EURAEC-1987) INFLUENCE OF PLATE THICKNESS, APPLIED STRESS, AND TEMPERATURE ON BRITTLE FRACTURE BEHAVIOUR IN THE ROBERTSON TEST. Progress Re-

port, October 1–December 31, 1967. Westgeest, B. Q. M.; van Elst, H. C. (Metaalinstituut TNO, Delft (Netherlands)). Jan. 16, 1968. Contract 081-67-1 TEEC (RD). 19p. (EUR-3785). Dep. CFSTI.

Work Performed under United States–Euratom Joint Research and Development Program.

The influence of applied stress and plate thickness on the crack arrest temperature in the Robertson test is investigated. Robertson specimens of Super-Elso steelplates of thicknesses 12.9, 20.5, 32.5, 82 and 130 mm were machined from plates with 130 mm thickness. For applied stresses of 20, 30, 50 and 80% of the yield stress the arrest temperature is determined. It was already verified that for the 12.9, 20.5 and 32.5 mm thickness the arrest temperature increases with increasing applied stress and increasing thickness between −40 and +19°C. (auth)

23760 (IN-1131) ANNUAL PROGRESS REPORT ON REACTOR FUELS AND MATERIALS DEVELOPMENT FOR FY 1967. Gibson, G. W.; Graber, M. J. (eds.). (Idaho Nuclear Corp., Idaho Falls). Feb. 1968. Contract AT(10-1)-1230. 157p. Dep. CFSTI.

Nine papers on reactor fuels and materials development are presented. A separate abstract was prepared for each paper. (J.C.W.)

For abstracts of individual sections see: 23192, 23235, 23714, 23761, 23762, 23843–23845, and 23859.

23761 (IN-1131, pp 2-29) DEVELOPMENT AND FABRICATION OF FUELS AND CLADDING MATERIALS. (Idaho Nuclear Corp., Idaho Falls).

Samples of Al−U alloys were prepared and the effects of silicon additions on fabrication and reprocessing the fuel elements was observed. An investigation was performed on the use of prerolled cores for fabrication of aluminum-clad fuel plates. Fe−Cr−Al−Y alloy is being investigated for nuclear fuel plate fabricability. The production of UCu_3 and U_3Si was carried out employing vacuum-induction heating method. Control of fuel plate care porosity was investigated. Density measurements were taken on stainless-steel–urania fuel plates before and after cold working, the change in density being a measure of the degree of fuel particle breakup. (J.C.W.)

23762 (IN-1131, pp 101-15) SPECIAL SUPPORT PROJECTS. (Idaho Nuclear Corp., Idaho Falls).

The failure of stainless steel type 316 welded tee assembly exposed to a NaK environment was analyzed to determine cause and extent of the cracking. Tensile specimens were machined from the piping and tests performed in air to determine maximum tensile stress at 21 and 760°C. MTR fuel elements were subjected to radiograph density measurements when excessive dogboning was indicated, examined by metallography, and results tabulated. (J.C.W.)

23763 (KAPL-3383) FATIGUE-CRACK GROWTH RATE STUDIES OF NUCLEAR PRESSURE-VESSEL STEELS. Mowbray, D. F.; Andrews, W. R. (Knolls Atomic Power Lab., Schenectady, N. Y.). Aug. 25, 1967. Contract W-31-109-eng-52. 23p. Dep. CFSTI.

Fatigue-crack growth rates were determined for ASTM A302-B and A508-2 steels in two characteristic plate and forging directions. Two different plate-specimen geometries were investigated. One specimen type had cracks growing from a centrally located through-the-thickness hole (through-crack specimen); the second specimen type had a part-through crack of semielliptical shape (surface-crack specimen). The loading cycle in all the tests was zero-to-tension at various constant gross-section stress levels, and the crack growth rates ranged from 10^{-5} to 10^{-3} in./cycle. Data obtained from the two specimen types were correlated upon the hypothesis that the crack extension per cycle was proportional to a positive power of the stress intensity factor. This hypothesis produced an excellent correlation of the data obtained from the through-crack specimens in both test directions. In addition, the rate of crack extension through the plate thickness of the surface-crack specimens was successfully correlated with data from through-crack specimens. (auth)

23764 (LA-DC-8964) CHARACTERIZATION OF COMMERCIAL REFRACTORY METAL AND METAL CARBIDE POWDERS. Riley, Robert Eldon (Los Alamos Scientific Lab., N. Mex.). [Dec. 1966]. Contract W-7405-eng-36. 40p. (CONF-680504-1). Dep. CFSTI.

From 2nd Powder Metallurgy Symposium, Stuttgart, Germany.

Complete characterization, including morphology, are essential to the successful and economical use of powders in powder metallurgy fabrication processes. The importance of metallographic examination cannot be overemphasized in the evaluation of other characterization data in the development of procurement specifications. By classing a powder into a specific morphological type of microstructure, it is possible to show a correlation between such parameters as average particle size and specific surface with the density of green and sintered compacts. A dense discrete particle observed in powder is Type B. Considering Type B as a function of grain size, offers some degree of predictability relative to sintered density. The aggregate particle Type C is less predictable because it is dependent upon the size of the individual particles which make up the aggregate. Characterization and compressibility and sintering data for pure molybdenum powders are summarized. Molybdenum powders doped with 1 wt % ThO_2 during manufacture are characterized. NbC, TaC, and ZrC samples were evaluated for characterization data, including metallographic examination results. (J.C.W.)

23765 (TRG-Report-1294) HETEROGENEITY IN THE DISLOCATION ASSEMBLY: ITS EFFECT UPON THE PROBABILITY OF FATIGUE FAILURE. Gittus, J. H. (United Kingdom Atomic Energy Authority, Springfields (England). Reactor Group). July 15, 1966. 11p. Dep. CFSTI.

Use is made of a model of a metal consisting of a statistical assembly of line and point defects to derive an expression for the mean dislocation velocity in terms of stress, temperature, and the frequency of atomic vibration. A diffusion equation that describes the movement, immobilization, and creation of dislocations is developed and solved to produce an expression which relates the mobile dislocation density with its extreme values, strain, and time. The positional dependence of strain in a cracked body under unidirectional or cyclically reversed stress systems is calculated. The behavior near the crack tip is thus related with the macroscopic conditions applied to the body as a whole, and this leads to a fatigue law for failure by crack propagation. Examination of experimental data for fatigue and creep of 20Cr–25Ni–Nb stainless steel and Magnox AL80 provides reasonable justification for the predicted form of stress, strain, frequency, and temperature dependence for mean life. (UK)

23766 (WANL-TME-1550) TENSILE PROPERTIES OF I-400 GRADE BERYLLIUM AT CRYOGENIC TEMPERATURES. Kesterson, R. L. (Westinghouse Electric Corp., Pittsburgh, Pa. [Pittsburgh, Pa.] Astronuclear Lab.). Dec. 1966. Subcontract NP-1. 15p. Dep. CFSTI.

The tensile properties of I-400 grade beryllium were investigated at −320 to +70°F. This material has a higher beryllium oxide content (5%) than the S 200 grade (2%) now in use and a grain size of one-half that of S 200. Fifteen notched and fifteen unnotched specimens were tested. The ultimate strength, 0.2% yield strength, percent elongation and modulus of elasticity were determined. The data showed the ultimate plain bar strength to be about 70,000 psi at all temperatures and the notched ultimate strength to vary from 72,000 psi at room temperature to 47,000 psi at −320°F. These values indicate I-400 to be very notch sensitive at cryogenic temperatures. The ductility was found to be low, varying from 0.23% at −320°F to 1.0% at room temperature. (auth)

23767 INFLUENCE OF NOTCHES ON THE FATIGUE RESISTANCE OF PRESSURE VESSEL STEELS. Hickerson, J. P.; Pense, A. W.; Stout, R. D. (Lehigh Univ., Bethlehem, Pa.). Weld. J. (N. Y.), 47: 63s-71s(Feb. 1968).

Previous investigations conducted on low-cycle fatigue behavior of pressure vessel steels including studies of materials and the effects of heat treatment, fabrication, and temperature are supplemented by this report which gives information on the influence of notches, holes, and fillets on the fatigue strain reduction factor. Results of this study are related to full scale pressure fatigue tests conducted by PVRC. Steels used in the experiments were a normalized and stress relieved steel A201A, A302B, a normalized and stress relieved Mn−Mo steel, and A517F, a complex quenched and tempered alloy steel. Examination of the crack propagation portion of the fatigue curves indicated that, once fatigue cracking had occurred, growth of the crack was independent of the type of initiating flow but was dependent on total strain range, loading condition, and material sensitivity. Comparison of the results of the tests on the three steels with the full scale vessel tests indicated that the crack propagation portion of the fatigue curve corresponded more closely to the fatigue life of a vessel than crack initiation and propagation and also provided a more realistic approach to design against fatigue failure. (P.G.C.)

23768 INVESTIGATION OF CORROSION OF REACTOR MATERIALS BY FLOWING LIQUID SODIUM AT HIGH TEMPERATURES. Borgstedt, Hans Ulrich; Drechsler, Guenther; Frees, Guenter (Kernforschungszentrum, Karlsruhe, Ger.). Werkst. Korros., 18: 894-7(1967). (In German).

An investigation was made of the corrosion characteristics of austenitic alloy steels which are candidate materials for fuel element cans for sodium cooled fast breeder reactors. The design and operation of the sodium corrosion test apparatus is described

in detail. The materials were tested in liquid sodium flowing at about 0.5 m/sec for 1000 hr with an oxide content of about 15 ppM, and at temperatures of 500, 550, and 600°C. The candidate materials included Cr-Ni steels, Inconel-X, Cr-Ni-Ti steels, and Ni-Ti-V alloys. Corrosion effects were determined by measurement of weight changes in the materials, chemical analysis, and light- and electron microscopy. The results showed that Cr-Ni steels are corrosion resistant in liquid sodium up to about 650°C. Above this temperature, these materials are limited by their annealed strength. The incorporation of materials of higher heat resistance also affects the corrosion problems. High nickel content alloys are susceptible to corrosion at higher sodium flow velocities, while vanadium alloys in Na with an oxide content of more than 15 ppM undergo strong pitting and embrittlement through oxygen diffusion. (L.C.L.)

23769 STRENGTHENING OF HCP Zr, Ti, AND Hf BY INTERSTITIAL SOLUTES: A REVIEW. Tyson, W. R. (Trent Univ., Peterborough, Ont.). Can. Met. Quart., 6: 301-32(Oct.-Dec. 1967).

Interstitial solutes in α Zr, Ti and Hf are very effective in raising the tensile flow stress, especially at temperatures up to about one half of the transformation temperature, with 1 at. % of solute increasing the room temperature yield strength by up to 50 kg/mm^2. Low-temperature deformation is controlled by a thermally activated process with an activation energy about $\mu b^3/6$ and activation volume as low as 22 b^3 at 0.5 at. %, probably a short-range interference by solute atoms with atomic motions at the core of gliding dislocations. The strengthening by N is twice that by O in Zr and Ti, consistent with the larger size of the N atom relative to that of the O atom. (auth)

23770 SURVEY OF STRUCTURAL MATERIALS FOR THE MOLTEN SALT EXPERIMENTAL (MOSEL) REACTOR. Metzger, G. E. (Materials Lab., Wright-Patterson AFB, Ohio). Nucl. Eng. Design, 7: 29-39(1968).

A survey of metal-base structural materials for use in molten lead and fluoride salts at 500 to 1000°C is presented. The mechanical properties, fabrication, and corrosion properties are the major items considered. The study was done with respect to the Molten Salt Experimental (MOSEL) reactor concept. (auth)

23771 INFLUENCE OF CARBURIZATION OF THE TUNGSTEN SURFACE LAYER ON THE SHIFT MODULUS AND INTERNAL FRICTION AT HIGH TEMPERATURE. Shestopal, V. O.; Sushakova, G. G. Fiz. Metal. Metalloved., 24: 1064-8(Dec. 1967). (In Russian).

A free torsional vibration method was used to study the shift modulus and internal friction in tungsten at 1100 to 2750°K. The strong carburization effects in tungsten reduced the recrystallization temperature about 300°. The temperature dependence of the internal friction and the shift defect in modulus were correlated. A strong creep of tungsten wire was observed at the recrystallization temperatures. (R.V.J.)

23772 X-RAY STUDY OF WIRE-DRAWN NIOBIUM AND TANTALUM. Adler, R. P. I.; Otte, H. M. Advan. X-ray Anal., 9: 115-30(1966).

X-ray investigation of deformation of the surface layers of drawn wires of Nb and Ta is reported. Nb and Ta rods, 3.2 mm in dia, annealed to produce grain size of 0.01 to 0.03 mm for Nb and 0.05 mm for Ta, are successively drawn to 0.5 mm dia. X-ray measurements are made between draws. For comparison, cold worked filings of Ta and Nb are compacted into 2.2 mm dia rods. Diffraction lines profiles, from negative and positive angles, are taken with a diffractometer using crystal monochromated CuK-alpha line. Measurements of peak position and line broadening are made and analyzed to obtain values for lattice parameter, root mean square strain and probability of faults, if present. Macroscopic residual strains, corresponding to equivalent longitudinal tensile stresses of 35 ± 5 kg/mm^2 are produced in outer layers of wires, but not in filings and remain constant after initial 2% reduction of area. Apparent particle size in $\langle 100 \rangle$ and $\langle 110 \rangle$ directions reaches limiting value of approximately 200 Å after the first few draws; no evidence of stacking faults is found. Filings show higher residual macroscopic strains than drawn wires but particle size is the same. (Rev. Metal Lit.)

23773 RELATIONSHIP BETWEEN THE CREEP CHARACTERISTICS AND THE POLYMORPHIC SUBSTITUTION TEMPERATURE IN TITANIUM–ZIRCONIUM–OXYGEN ALLOYS. Glazova, V. V. (Inst. of Metallurgy, Moscow). Dokl. Akad. Nauk SSSR, 177: 1394-6(Dec. 21, 1967). (In Russian).

The creep rate logarithm was studied as a function of Ti–Zr–O composition for the cross sections of 1 at % O, 5 at % O, and Zr–TiO_2 at 300, 400, 500, 600, and 700°C. The results obtained showed the strengthening effects of oxygen used as an alloying impurity in the Ti–Zr alloys at temperatures up to 700°C. (R.V.J.)

23774 INVESTIGATION OF THE EFFECT OF SIMPLE AND BINARY CARBIDES OF THE METALS OF THE IV–V GROUPS ON SOME PROPERTIES OF CERMET NICKEL. Boiko, P. A.; Moroz, A. L. (Kiev Polytechnic Inst.). Porosh. Met., Akad. Nauk Ukr. SSR, No. 1, 48-54(Jan. 1968). (In Russian).

The effect is reported of simple and complex carbides: ZrC, TaC, HfC, 4 ZrC–TaC, and 4 ZrC–HfC on hardness and porosity of sintered nickel and on the temperature of maximum loss of hardness and resistance to oxidation of pure nickel and nickel containing 0.5 to 16% by volume of simple and binary carbides. (tr-auth)

23775 EFFECT OF TITANIUM ON THE MELTING POINT AND TRANSITION TEMPERATURE OF YTTRIUM. Beaudry, B. J. (Ames Lab., Iowa). J. Less-Common Metals, 14: 370-2 (Mar. 1968). (IS–1710).

Seven alloys of Ti and Y, in the composition range of 0.5 to 11.5 at. % Ti, were studied to determine the effect of Ti additions on the melting point and transition temperatures of Y. A phase diagram shows results of differential thermal analysis of distilled Y and of Ti–Y alloys. (P.G.C.)

23776 GAGING AND FLAW DETECTION IN METALS USING X-, β-, AND γ-RAYS. Vardhan, Harsh (Solid State Physics Lab., Delhi). Res. Ind. (New Delhi), 11: 8-13(1966).

Modern techniques of gaging and flaw detection in metals, using x- and γ-rays and beta particles are presented. The relative advantages they offer and the specific situations that dictate the preferential use of one over the other are delineated. (Indian Sci. Abstr.)

23777 THERMOPHYSICAL PROPERTIES OF SODIUM: RECOMMENDED VALUES. Golden, Gerald H.; Tokar, John V.; Miller, David. Reactor Fuel-Process. Technol., 11: 27-48 (Winter 1967–68).

Data on the liquid density, vapor pressure, thermodynamic properties, transport properties, electric resistivity, surface tension, liquid thermal expansion coefficient, liquid compressibility, and sonic velocity are presented in tables and graphs. (M.C.G.)

23778 IMPROVED BERYLLIUM–COPPER ALLOY MACHINES QUICKLY, SMOOTHLY. Iron Age Metalwork, Int., 6: 42-3(Jan. 1967).

A new alloy, Berylco 33-25, has a machinability at least 75% of that for free-machining brass but retains the strength, conductivity, hardness and corrosion resistance of beryllium copper alloy 25. The new alloy is nonmagnetic and retains its physical property values over a wide temperature range. Applications include precision electrical contacts and connectors. (Rev. Metal Lit.)

23779 EFFECT OF Zn ON THE PROPERTIES OF HIGH-TEMPERATURE ALLOYS OF THE Mg–Nd–Zr SYSTEM. Tikhova, N. M.; Blokhina, V. A. Litenoe Proizvod., No. 1, 37-40(1966). (In Russian).

The effect of the addition of 0.1 to 1.0% Zn on the properties of Mg alloys with 1.5 to 3.5% Nd and 0.5 to 0.7% Zr, as consisting in hardening through alloying of the solid solution, is investigated. Microstructural examination showed that treatment with Zn within the specified limits does not markedly affect the microstructure of the cast or heat-treated alloy (8-hr hardening at 535°C for alloys with ≤0.8% Zn and 510°C for alloys with 1% Zn, cooling in air with subsequent aging). In cast state the microstructure of the alloys consists of grains of the solid solution of Nd, Zn and Zr in Mg and of an eutectic along the grain boundaries. The composition of the eutectic includes a metallic compound, apparently $Mg_{12}Nd$. The positive effect of Zn on the ultimate strength of the alloys is apparently conditioned by hardening of the solid solution. This hardening of the solid solution is attributed to the concentration of small groups of dissolved atoms at definite lattice sites. The dissolved atoms in limited quantities form atmospheres around the dislocations and thus enhance the critical tension of the migration of dislocations, wedging the dislocations in, and hardening the alloys. Around the lattice vacancies atoms with various diameters accumulate which enhance lattice stability. Such accumulations, which reduce the lattice free energy, inhibit the displacement and diffusion processes of transition and increase the strength of alloys. This is exemplified by the addition of Zn. Apparently the addition of Zn contributes to a stable state of the alloy's crystal lattice. Other positive effects of Zn-treated ML10 alloys, as compared with Zn-free ML5, ML9, ML10, and ML15 alloys, are: better weldability, higher corrosion resistance, higher yield strength. (ATD)

23780 BRITTLE BEHAVIOR IN EXTRUDED BERYLLIUM TUBES. Sumner, G. Int. J. Fracture Mech., 2: 448-59(June 1966).

An investigation of brittle fracture in extruded Be tubes is described following an unusual brittle fracture of a Be-clad fuel element at plastic strain of about 0.15% produced by differential

thermal contraction. A characteristic spiral form of fracture is shown to be caused by cleavage failure of the highly textured tube along $(11\bar{2}0)$ planes under biaxial stress generated by the contraction of the can onto the pellets, but the crystallography of the fracture does not reveal cause of the unexpectedly low plasticity. Mechanical testing of the tubes reveals circumferential ductilities of about 1% which is in agreement with values expected from the high degree of texture of the tube; axial ductilities were anomalously very low at about 0.2%. Less textured materials gave longitudinal ductilities of several percent, expected from the texture. Thin filaments cut from the walls of double extruded material gave much greater elongations than the whole tube, showing that the material was not inherently brittle and tests on filaments of varying arc widths suggested that progressively increasing the width of curved specimens was accompanied by decreasing ductility. Some evidence is presented supporting the theory that the brittleness is caused by premature failure following the action of a secondary deformation process activated by transverse loop stress arising from the plastic anisotropy of the material and the tube curvature. It is suggested that this process is twinning which is known to lead to nonductile failure. (Rev. Metal Lit.)

23781 ADHESION INTERACTION IN VACUUM OF REFRACTORY METALS, SINTERED METAL-LIKE COMPOUNDS, AND SINTERED HARD ALLOYS. Semenov, A. P.; Pozdnyakov, V. V. Mashinovedenie, No. 1, 116-27(1967). (In Russian).

Pairs of similar and dissimilar metals were formed by bringing into contact specimens of Ti, Zr, Nb, Ta, Mo, W, and Co under a load of 4 to 5 kg in a vacuum of 10^{-4} to 10^{-5} mm Hg at temperatures up to 0.7 of the melting temperature of the low-melting component of the pair (T_{mel}). The paired specimens contacting each other at their end faces were held under the load for 3 min and then pulled apart to determine the adhesion interaction between them. The ratio of the applied load to the force required to break the joint, tentatively designated the adhesion coefficient, was used as the criterion of the adhesion capacity of the tested materials. Similar tests were also made on specimens of TiC, VC, Cr_3C_2, NbC, Mo_2C, WC, and CrB sintered carbides and borides and also on specimens of sintered tungsten carbide-base hard alloys. All tested combinations of similar and dissimilar materials at definite temperatures exhibited adhesion interaction in vacuum, which appeared to be a common phenomenon for all crystalline solid bodies. Adhesion interaction of similar pure metals began in the 0.3 to 0.4 T_{mel} range; dissimilar pure metals began to interact in the 0.35 to 0.45 T_{mel} range. The adhesion interaction of similar pure metals was found to depend on their electron structure. Adhesion interaction of pure dissimilar metals is determined by their position relative to one another in the periodic table, by the ratio of their atomic radii, and by the type of their crystal lattices. The beginning of adhesion interaction of tested refractory carbides and borides occurred in the 0.43 to 0.67 T_{mel} range. The temperature of the beginning of the adhesion interaction of tungsten carbide-base hard alloys depends on the content of the cobalt bond, and lies between the respective values of the temperatures for pure cobalt and tungsten carbide. The described method was successfully used to determine, at various temperatures, the adhesion interaction between the cutting tool and the machined material. (JPRS)

23782 METAL RESEARCH FOR SPACE ENGINEERING. Lorant, Michael. Mass Prod., 43: No. 4, 41-5(Apr. 1967).

Various examples are cited to illustrate the development and application of new and modified metals, alloys and techniques for mass production in space engineering. Discussed are development of Ag–Pd–Mn brazing alloy for brazing structural material having high strength-to-weight ratio at high temperatures, use of molybdenum sulfide as a lubricant in space engines, development of tin, sapphire and graphite whiskers, diffusion bonding and spinning metallic materials in a revolving vessel to form parabolic reflectors and lenses for antennae. New uses for Au, Zr, Nb, and W are briefly mentioned. (Rev. Metal Lit.)

23783 ROLLING AND ANNEALING TEXTURES IN Cu–Be ALLOYS. Henmi, Zenzo; Nagai, Takeshi. Nippon Kinzoku Gakkaishi, 31: 322-8(Apr. 1967). (In Japanese).

The rolling and annealing texture in Cu–Be alloy is investigated. The rolling texture in Cu–2% Be alloy is $(\bar{1}10)$ $[1\bar{1}2]$ (alpha-brass type) and in Cu–25% Be alloy is (110) $[1\bar{1}2]$ but not alpha-brass type. The annealing texture in Cu–2% Be, rolled 90% and annealed for 30 min at 600°C is (123) [10.1.4], which is different from alpha-brass type (225) $[7\bar{3}4]$. Cu–25% Be alloy rolled 75% and annealed for 30 min at 500°C is partly (110) $[1\bar{1}2]$ texture. In an investigation of the texture of gamma-phase in Cu–2% Be rolled 90% and annealed 30 min at 400°C, it was found that gamma has a weak texture. (Rev. Metal. Lit.)

23784 BOOSTING LIGHT METAL PROPERTIES WITH BERYLLIUM. Wikle, K. G. Foundry, 95: No. 4, 86-90(Apr. 1967).

Small additions of Be (0.005 to 0.05%) to Al-base melts results in cleaner metal, and higher quality castings with better surface, higher strength and more ductility. In addition, it prevents preferential oxidation of Mg, provides good control of the Mg content, and reduces the reaction with sand molds. As with Al alloys, small additions (0.001 to 0.005%) of Be to Mg melts cause formation of a protective surface film high in BeO. The film reduces the tendency of Mg to burn, suppresses oxidation of Mg during meltdown, holding, transfer and castings, and reduces the need for cover fluxes. Be can be added conveniently to Al and Mg alloys in the form of master alloys. Most commonly used are Al–5Be, Al–5Be–5Mg, Al–1½ Be and Al–1Be–1Mg master alloys. (Rev. Metal Lit.)

23785 WELDING OF REFRACTORY ALLOYS. Davis, C. P.; McGregor, Wells P. Machinery (N. Y.), 73: No. 9, 92-3 (May 1967).

Nb alloys, T-111 Ta and TZM Mo in foil form (0.006 to 0.012 in. thick) were joined by electron beam and Tig fusion welding processes. Weldments were nondestructively tested prior to mechanical testing. D36 Nb was the most weldable of the alloys tested, followed by Cb-752, D43, and FS85. TZM Mo alloy joints were generally unreliable because of embrittlement in the weld and heat affected zone. Resistance and ultrasonic spot welding were also attempted but are less promising because of electrode and sonotrode sticking. (Rev. Metal Lit.)

23786 ON THE PROPERTIES OF HEAVY-SECTION STEEL FOR NUCLEAR PRESSURE VESSEL. I. ON THE PROPERTIES OF HEAVY-SECTION Mn–Mo–Ni STEEL PLATE FOR NUCLEAR PRESSURE VESSEL. Onodera, Sinsaku; Miyano, Katao (Japan Steel Works, Ltd.). Tetsu To Hagane, 52: 594-6(Apr. 1966). (In Japanese).

ASTM-A-302B improved steel plates, 150 and 250 mm in thickness, for use in reactor pressure vessels were studied to find the relations between the heat-treatment and the mechanical properties, and between the long stress relief annealing of temper-quenched plates and the mechanical properties and low-temperature toughness. Steel plate of 150 and 250 mm in thickness has the required strength if it is properly treated by normalizing and quenching. The mass effect on toughness in steel was greater at low-temperatures. The impact transition curves for 150 and 250 mm plates of ¼ tons shifted about 40% to the low temperature side by tempering and quenching, compared with normalization-quenched plates. The yield strength of temper-quenched plates was somewhat decreased by long stress relief annealing, but their elongation was not much changed. The 2 mm Charpy-V impact value was decreased with elapsed time. After 100 hours it was decreased down to ⅔ of that of the mother material. It was confirmed that the 250 mm steel plate could be manufactured in accordance with the nuclear specification. This was also the case for the plate of maximum size 3200 × 3500 mm with maximum width 400 mm and maximum weight 60 tons. (NSA of Japan)

23787 ON THE PROPERTIES OF HEAVY-SECTION STEEL FOR NUCLEAR PRESSURE VESSEL. II. ON THE PROPERTIES OF ASME, SA336 STEEL RING FORGING. Onodera, Shinsaku; Fukamachi, Kisaburo (Japan Steel Works, Ltd.). Tetsu To Hagane, 52: 732-5(Apr. 1966). (In Japanese).

Forged materials are being tested for use in reactor pressure vessels. Forged steel rings were fabricated from the Ni–Cr–Mo steel equivalent to ASME–SA336 and Case 1236, and their mechanical properties were tested. The rings were 1510 mm in outside dia, 270 mm in thickness and 1200 mm in length, before the heat-treatment. In the 0.20 and 10.15% of C content, the latter was superior in the impact toughness. This is because of the large effect of C content on the impact toughness, and not the effect on the quenchability. In the mechanical properties of 0.15% rings, the mass effect on impact properties was especially noticeable; this is natural because of the cooling condition in the annealing. In the interior, an impact value of about 6.5 kg cm/cm² was obtained at −12°C. The changes in the mechanical properties of stress relief annealing after the welding were small. It was found that the mechanical properties of the forged rings could meet the standards for reactor pressure vessel materials. (NSA of Japan)

23788 STRENGTHENING MECHANISM OF MOLYBDENUM-BASE ALLOYS. Gol'tsev, V. P. Dokl. Akad. Nauk BSSR, 10: 954-6(1966). (In Russian).

Several series of specimens of molybdenum-base alloys containing 0.3 to 1.0% vanadium, 0.2 to 0.7% titanium, 0.1 to 0.5% hafnium or zirconium, 0.06 to 0.2% lanthanum or 0.03 to 0.1% yttrium were tested for their mechanical properties. It was found that all the alloying elements tested increase the tensile and yield strength and lower the ductility. Lanthanum and yt-

trium have a strengthening effect only at contents of about 0.05 to 0.06%; at higher contents they lower the strength and increase the hardness. In alloys containing 0.5% titanium, 0.2% hafnium, 0.2% zirconium, 0.1% lanthanum or 0.06% yttrium, more than 95% of the alloying elements combined with oxygen, nitrogen or carbon. In alloys containing vanadium, 50 to 60% vanadium was combined with oxygen, nitrogen or carbon. Consequently, a very small amount (less than 0.02%) of alloying elements was found to form solid solutions with molybdenum. Inclusions found in alloys were mainly oxides of alloying elements. Therefore, the investigated alloys are not true binary alloys, but can be considered as pseudoternary Mo–Me–MeO alloys. It was concluded that the presence of finely dispersed particles of a second phase, such as MeO, MeC or MeN, prevents recrystallization and grain growth and increases the strength of molybdenum-base alloys in accordance with the mechanism of dispersion strengthening. (ATD)

23789 FORGING TECHNOLOGY EXPANDS TO MEET MARKET NEEDS. Obrzut, J. J. Iron Age Metalwork. Int., 6: No. 7, 26-7(July 1967).

Sizes of parts to be forged for use in aircraft, earth moving equipment, undersea vehicles and power industry equipment are large. In addition to dimensions, the forgeability, available pressures and closed die capability must be considered when forging. Examples of forging large parts are cited. The advantages of precision forging are listed; it is suitable for Mo, Nb-base alloys, Waspaloy, Rene 41 and other superalloys. Integral shafts used in radial forging of 130 to 180 mm dia turbine wheels and spur gears are discussed. A split-die multiple ram technique is illustrated. It can be applied vertically or horizontally to forge difficult-to-form alloys. Automation of the forging processes is also discussed. (Rev. Metal Lit.)

23790 EVIDENCE FOR DIFFUSIONAL CREEP WITH LOW STRAIN RATE SENSITIVITY. Backofen, W. A.; Murty, G. S.; Zehr, S. W. (Massachusetts Inst. of Tech., Cambridge). Trans. Met. Soc. AIME, 242: 329-31(Feb. 1968).

Experiments are reported which revealed metallographic indications of diffusional creep. The resistance to tensile necking conferred by Newtonian viscosity is lost which became increasingly apparent through the formation of more sharply defined necks. Work was performed on an extremely fine grained alloy of Mg with about 6% Zr. (F.S.)

23791 RECRYSTALLIZATION IN ALPHA PLUTONIUM. Nelson, R. D. (Battelle Memorial Inst., Richland, Wash.). Contract AT(45-1)-1830. Trans. Met. Soc. AIME, 242: 331-2(Feb. 1968). (BNWL-SA-1411).

Recrystallization with concurrent deformation was found to occur in α plutonium. Properties of the recrystallized metal are different from as-cast metal. The plutonium was prepared by electrorefining. (F.S.)

23792 CREEP CORRELATIONS FOR Bcc REFRACTORY METALS. Vandervoort, Richard R. (Univ. of California, Livermore). Contract W-7405-eng-48. Trans. Met. Soc. AIME, 242: 345-7(Feb. 1968). (UCRL-70618).

An empirical relationship is given which is used in describing the deformation behavior of all of the refractory metals except tungsten. The correlation of creep data and strain rate-grain size indicates that the high temperature deformation behavior of fcc, hcp, bcc metals is in general agreement. (F.S.)

23793 PLASTIC DEFORMATION OF NIOBIUM (COLUMBIUM)–MOLYBDENUM ALLOY SINGLE CRYSTALS. Milne, I.; Smallman, R. E. (Birmingham Univ., Eng.). Trans. Met. Soc. AIME, 242: 120-6(Jan. 1968).

The deformation behavior of single crystals of Nb–Mo alloys has been investigated with particular reference to the influence of composition, orientation, and temperature. Strong solid-solution hardening was observed reaching a maximum at the equiatomic composition and can be attributed to the difference in atomic size between niobium and molybdenum. Changes in the form of stress-strain curve, as shown by a high work-hardening rate and restricted elongation to fracture, were observed at a composition of Nb-85% Mo and are attributed to the presence of Mo_2C precipitate. Conjugate slip was only extensive in dilute alloy samples; at the 50/50 composition deformation mainly occurred by primary slip, and the onset of conjugate slip gave rise to failure by cleavage on {100}. The variation of yield stress of Nb-50% Mo with orientation was consistent with slip on {011} ⟨111⟩ slip systems. The temperature dependence of the yield stress at −196 and 250°C was similar to that of pure bcc metals, but at a much higher stress level; no evidence for twinning was found. (auth)

23794 SUPERPLASTICITY OF UNALLOYED BETA PLUTONIUM. Dahlgren, S. D. (Battelle Memorial Inst., Richland, Wash.). Contract AT(45-1)-1830. Trans. Met. Soc. AIME, 242: 126-32(Jan. 1968).

The plasticity of unalloyed β plutonium was studied by evaluating the strain-rate-hardening exponent, m, in the equation $\sigma = K\dot{\epsilon}^m$. Values of m up to 0.33 and tensile elongations up to 680 pct were obtained for β plutonium formed directly from the α phase. Cast bars that were $\alpha \rightarrow \beta \rightarrow \alpha \rightarrow \beta$ cycled and tested had lower flow stresses and higher values for m($m \leq 0.45$) than uncycled bars, but their total plastic elongations were not as great as expected because of premature failure at voids formed during cycling. Flow stresses were higher and m was lower ($m \approx 0.15$) for β plutonium formed from the γ phase. (auth)

23795 EFFECT OF ALLOYING ON WORK HARDENING OF TANTALUM SINGLE CRYSTALS. Mordike, Barry L.; Rudolph, Guenther (Liverpool Univ.). Z. Metallk., 59: 219-21(Mar. 1968).

High purity single crystals of Ta–Mo and Ta–Nb alloys were deformed in compression at 78 to 573°K. The influence of alloying content on the yield stress, work hardening rate, and shape of the stress-strain curve was determined. Molybdenum affected the deformation parameters whereas under most conditions the stress strain curves of Ta–Nb alloys and pure tantalum are identical. (auth)

23796 PRECIPITATION PROCESSES IN THE MOLYBDENUM–IRON SOLID SOLUTION STUDIED ON THE EXAMPLE OF AN ALLOY CONTAINING 8 WT. PERCENT Fe. Wachtel, Ernst; Gebhardt, Erich; Chakraborty, Amiya Kumar (Max-Planck-Institut fuer Metallforschung, Stuttgart). Z. Metallk., 59: 188-93(Mar. 1968). (In German).

The precipitation behavior of supersaturated homogeneous molybdenum-iron solid solutions is investigated on the example of an alloy containing 8 wt. % Fe. To this end measurements of magnetic susceptibility, resistivity, and hardness were carried out as functions of annealing temperature and time. Furthermore normal and electron microscopical investigations were carried out in connection with electron diffraction patterns. At annealing temperatures of 950, 800, and 700°C a discontinuous lamellar consisting of Mo_6Fe_7 is formed after completion of various partial processes, each being separately discussed. In contrast to this an iron-rich solid solution is precipitated at lower annealing temperatures of 600 and 500°C. Its formation is attributed to the existence of a metastable solubility gap. (tr-auth)

23797 HIGH STRENGTH, DUCTILITY, CORROSION RESISTANCE: MULTIPHASE ALLOYS HAVE ALL THREE. Smith, Gaylord D. (International Nickel Co. Inc., New York); Yates, Daniel H. Metal Progr., 93: No. 3, 100-2(Mar. 1968).

Quaternary alloys of Co–Cr–Mo–Ni were developed which combine high tensile strength, toughness, and ductility with resistance to corrosion and stress corrosion. The alloys have a fcc structure at elevated temperature and are transformed to an hcp structure by extrusion, rolling, swaging, or cold rolling to give greater strength. (P.G.C.)

23798 STANDARDS FOR NUCLEAR FUEL MATERIALS. Johnson, E. R. Mag. Stand., 38: 133-5(May 1967).

New standards consist of chemical and physical specifications for nuclear grade U metal melt stock, sinterable UO_2 and compactible UO_2. Total impurity content is expressed as B equivalents rather than as individual limits of impurity levels. A fourth standard compiles standard analytical and testing techniques for nuclear fuel materials. (Rev. Metal Lit.)

23799 PRIMARY CREEP OF MAGNOX AL80 FROM 450°C TO 620°C. Noden, J. D. (Central Electricity Generating Board, Berkeley, Eng.); Willoughby, G. Metallurgia, 77: 111-15(Mar. 1968).

The primary creep data of Magnox AL80 at 450 to 620°C, may be represented by the following general equation: $\epsilon = 3.2 \times 10^5 \sigma^{\frac{1}{2}} t^{0.7} e^{-32000/RT}$. Changes in grain size during the primary creep stage make it difficult to determine a precise structure factor, but it is suggested that a function of grain size may be incorporated so that: $\epsilon = 1.2 \times 10^3 d^{-\frac{1}{2}} \sigma^{\frac{1}{2}} t^{0.7} e^{-32000/RT}$ where ε = primary creep strain in %; d = mean grain diameter in inches at end of primary creep stage; σ = stress in lb/sq in.; t = time in hours; R = gas constant = 1.98 cal $mole^{-1}$ deg^{-1}; and T = temperature in °K. It has been shown that the secondary creep rate may be related to the primary creep strain at a particular time. Approximate values of the secondary creep rate may be derived from short term primary creep tests by application of the equation: $\dot{\epsilon} \approx 0.23 \epsilon^{\frac{1}{2}} t^{-1}$ where $\dot{\epsilon}$ = secondary creep in %/hr. (auth) (UK)

23800 VOLUME AND GRAIN-BOUNDARY DIFFUSION OF IRON IN 20 Cr/25 Ni/Nb STAINLESS STEEL. Smith, A. F.; Gibbs, G. B. (Central Electricity Generating Board, Berkeley, Eng.). Metal Sci. J., 2: 47-50(Mar. 1968).

Tracer diffusion of ^{59}Fe in 20 Cr–25 Ni–Nb stainless steel was

measured for two different grain sizes: 2 to 4 mm and ~50 μm. Volume diffusion dominates in the coarse-grained material at 750 to 1300°C. Above 900°C it is entirely lattice diffusion, described by $D_L = 1.74 \exp(-67.9 \times 10^3/RT)$ cm² sec⁻¹. At lower temperatures there is evidence of "short-circuiting" by dislocation pipes, and the results are consistent with a pipe-diffusivity $D_p = 20 \exp(-37 \times 10^3/RT)$ cm² sec⁻¹. In fine-grained material grain-boundary diffusion dominates between 600 and 900°C and is described by the relation $\delta D_B = 8.3 \times 10^{-7} \exp(-43 \times 10^3/RT)$ cm³ sec⁻¹. (auth)

23801 OXYGEN DEPENDENCE OF STRAIN-AGEING IN NIOBIUM. Szkopiak, Z. C. (Univ. of Surrey, London). Acta Met., 16: 381-91(Mar. 1968).

The effect of oxygen content on the strain-aging behavior of electron-beam-refined niobium has been studied, using both yield point return and internal friction measurements. The strain-aging index, given by $\Delta\sigma_y = \Delta\sigma_i + 2k_y d^{-\frac{1}{2}}$, has been found to be proportional to the amount of oxygen migrating from free solid solution. The dislocation locking parameter k_y attains a saturation value, which increases with increasing initial oxygen content, but is smaller than that for the annealed material. The results indicate that the smaller value of k_y is primarily due to the increased density of dislocations in the strain-aged material. $\Delta\sigma_i$, the increase in flow stress, commences to grow only after the k_y parameter is almost saturated, and is associated with oxygen atoms which migrate to dislocations beyond the saturation of Cottrell atmospheres. (auth)

23802 THEORY OF THE TENSILE DUCTILE-BRITTLE BEHAVIOR OF POLYCRYSTALLINE HCP MATERIALS, WITH APPLICATION TO BERYLLIUM. Armstrong, R. W. (Univ. of California, Livermore). Acta Met., 16: 347-55(Mar. 1968). (UCRL-70611).

A number of the hcp metals, such as Be, are similar to other potentially brittle materials, most notably, steel, in that they all show in a certain range of temperature an abrupt change in ductility. In the hcp case, the transition in behavior is reasonably sensitive to the polycrystal grain size. An explanation is given for this dependence and for other variations in the ductile–brittle behavior in terms of the theory and experiments underlying the (Hall–Petch) stress-grain size equations. The theory for the behavioral change is connected in an important way with critical resolved shear stress measurements for various deformation systems in single crystals. (auth)

23803 METALLURGIYA I METALLOVEDENIE CHISTYKH METALLOV. VYPUSK 6. (Metallurgy and Pure Metal Metallography. Volume 6). Emel'yanov, V. S.; Evstyukhin, A. I. (eds.). Moscow, Atomizdat, 1967. 196p.

Twenty articles are included on methods for producing pure metals (W, Zr, Nb, and Sn) and their compounds from the gaseous phase. Properties of W, Zr, Nb, and Sn, their alloys, chlorides, and iodides were analyzed and their uses in atomic industry discussed. Preparation of superconducting coatings and properties of Mo crystal fine structures are also discussed. Data are presented on the physical, mechanical, and diffusion properties of U, Mo, and alloys of Zr with Nb and C. Devices and instruments used in metal studies are described. (R.V.J.)

Structure and Phase Studies

Refer also to abstract 24388.

23804 (CONF-670502–, pp 29-35) MAGNETIC AND ELECTRICAL PROPERTIES OF SOME Yb–Sb PHASES. Bodnar, R. E.; Steinfink, H.; Narasimhan, K. S. V. (Texas Univ., Austin).

A study of ytterbium valence variations in Sb–Yb alloys was made, based on magnetic susceptibility data. The magnetic susceptibility measurements were made in the range from 325 to 1.70°K using the Faraday technique. Only the YbSb phase exhibited near trivalent Yb, Yb_4Sb_3 exhibited a valence between 2 and 3, and Yb_5Sb_3 and $YbSb_2$ were divalent. (M.C.G.)

23805 (CONF-670502–, pp 156-65) TERNARY COMPOUNDS HAVING THE $CeCu_2$-TYPE STRUCTURE. Dwight, A. E. (Argonne National Lab., Ill.).

The occurrence and unit cell constants of ten ternary compounds are reported. The compounds are formed when Y, Sm, Gd, Tb, Dy, Ho, Er, Tm, Yb, or Lu are alloyed with Ni and Ga in equiatomic proportions. These are members of a family of orthorhombic compounds with the $CeCu_2$-type structure. From x-rays diffraction data on powdered specimens, approximate atomic positional parameters and interatomic distances were obtained. An examination of the structure indicates that the rare earth atoms are aligned parallel to the b axis of the unit cell while the Ni and Ga atoms are aligned parallel to the a axis. The effect on the unit cell dimensions of ternary and quaternary substitutions is discussed. (auth)

23806 (CONF-670502–, pp 416-27) METALLOGRAPHIC STUDY OF THE ALLOTROPIC PHASE TRANSFORMATIONS IN CERIUM. Koch, C. C.; McHargue, C. J. (Oak Ridge National Lab., Tenn.).

Some aspects of the phase transformations in cerium were studied by using metallography. The percent dhcp formed by athermal transformation vs temperature as determined by x-ray diffraction was confirmed by quantitative metallography. The influence of plastic deformation on the transformation was studied by deforming cerium specimens at temperatures above and below M_s. Metallography definitely indicated that deformation promotes the fcc → dhcp reaction. A M_d temperature was determined. It appears that a tensile component of deformation is necessary for the fcc → dhcp transformation, which may explain the conflicting evidence of the effect of deformation on this transformation. The influence of deformation on subsequent athermal transformation and reversion was studied. The morphology of the fcc ⇌ dhcp transformation was examined and lattice relationships inferred. (auth)

23807 (CONF-670502–, pp 428-39) YTTRIUM–LEAD ALLOY SYSTEM. Carlson, O. N.; Schmidt, F. A.; Diesburg, D. E. (Ames Lab., Iowa).

The yttrium-lead alloy system was investigated by thermal analysis and microscopic and x-ray methods. An inverse peritectic reaction occurs on the yttrium-rich end of the system and there is a eutectic at 14 at. % Pb and 1240°C between yttrium and the compound, Y_5Pb_3, which melts congruently at 1760°C. The lead-rich side of the system consists of a series of peritectic reactions associated with three additional compounds. From x-ray diffraction data and microscopic evidence, the compositions of these compounds were determined to be Y_5Pb_4, YPb_2, and YPb_3. Horizontals corresponding to the decomposition temperatures of these compounds occur at 1650, 945, and 740°C, respectively. (auth)

23808 (CONF-670502–, pp 440-8) YTTERBIUM–LEAD AND EUROPIUM–LEAD SYSTEMS. McMasters, O. D. (Iowa State Univ. of Science and Technology, Ames. Inst. for Atomic Research).

Differential thermal, metallographic, and x-ray parametric methods were used to establish the ytterbium– and europium–lead phase diagrams. The terminal solid solubilities, eutectic points, liquidus curves, and horizontal reaction temperatures of these systems were determined. The intermetallic compounds Yb_2Pb, YbPb, $YbPb_3$, Eu_2Pb, EuPb, and $EuPb_3$ melt congruently. Both YbPb and EuPb compounds exhibit a polymorphic transformation. Compounds Yb_5Pb_3 and Eu_5Pb_3 form a peritectic reaction. Lattice parameter values and crystal structure data are given for most of these compounds. The valency characteristics of the rare earth component in these alloys are discussed. The crystal chemistry of these compounds are compared to those of the alkaline earth and trivalent rare earth compounds. (auth)

23809 (CONF-670502–, pp 449-51) SYNTHESIS AND IDENTIFICATION OF INTERMETALLIC COMPOUNDS IN THE Fe–Ho SYSTEM. O'Keefe, T. J.; Roe, G. J.; James, W. J. (Missouri Univ., Rolla).

Intermediate phases in the iron–holmium system were investigated by means of x-ray diffraction, electron microprobe analysis, and metallographic techniques. The phases either definitely or tentatively identified were $HoFe_2$, $HoFe_3$, Ho_6Fe_{23}, $HoFe_5$, and Ho_2Fe_{17}. The lattice parameters were determined by the Straumanis technique using Fe Kα radiation. Work in progress is also discussed. (auth)

23810 (CONF-670502–, pp 452-7) CERIUM–IRON AND CERIUM–NICKEL BINARY SYSTEMS. Gebhart III, J. M.; Etter, D. E.; Tucker, P. A. (Mound Lab., Miamisburg, Ohio).

Phase equilibria in the cerium-iron and cerium-nickel binary systems were investigated by differential thermal analysis, thermal analysis, metallography and x-ray diffraction, and a phase diagram was developed for each binary system. The present work shows considerable disagreement with the earlier diagrams in the liquidus temperatures as well as the temperatures and compositions of the binary invariant points. Many of these discrepancies are probably the result of differences in purity of the cerium metal used in the studies. The current studies were conducted with cerium that melted at 804°C and had a reported purity of 99.9%. (auth)

23811 (CONF-670502–, pp 458-68) STUDIES OF THE SAMARIUM–GADOLINIUM SYSTEM. Yamamoto, A. S.; Lundin, C. E. (Denver Research Inst., Colo.).

Phase relations in the Sm-Gd alloy system were established by collective analysis of various data. These data were obtained

from microscopic examination, x-ray diffraction analysis, thermal analysis, density and microhardness measurements, as well as Knudsen-effusion experiments. Thermodynamic activities of samarium in the hexagonal close-packed phase in the temperature range from 1073 to 1373°K were calculated from the vapor-pressure data obtained in the Knudsen effusion studies. A plot of activities versus mole fraction showed a negative deviation from ideality, or a tendency for unlike atom attraction. The phase equilibria exhibited complete miscibility both in liquid and solid. The characteristics of the two component metals are very similar, thus favoring the formation of such continuous solutions. Both metals are close-packed hexagonal, but differ in crystallographic stacking sequence from samarium-like (ABABCBCACA ...) to gadolinium-like (ABAB ...), which is reflected in the alloy system by a gradual transition from the samarium structure to the gadolinium structure. (auth)

23812 (INR-873/XIV/PS) BADANIA METALOGRAFICZNE I RENTGENOGRAFICZNE STRUKTUR PRZEMIANY IZOTERMICZNEJ $\beta \rightarrow \alpha$ W STOPIE U–Cr 0,4 PERCENT CIEZ. Cr. (Metallographic and X-Ray Investigations of the Isothermal Transformation $\beta \rightarrow \alpha$ in U–0.4 Wt Percent Cr Alloy). Hofman, Andrzej (Institute of Nuclear Research, Warsaw (Poland)). 1967. 18p. Dep. (In Polish).

The isothermal phase transformation $\beta \rightarrow \alpha$ of U–0.4 wt % Cr alloy at 630 to 400°C was investigated by means of metallography and x-ray analysis. The results are in agreement with previous suggestion, based on the dilatometric measurements that there are two C-curves (in the temperature range taken into account). A suggestion on the explanation of the existence of two transformation mechanisms $\beta \rightarrow \alpha$ for upper and lower C-curves is given. (auth)

23813 (INR–874/XIV/PS) BADANIA DILATOMETRYCZNE KINETYKI PRZEMIANY $\beta \rightarrow \alpha$ W STOPIE U–0,4 PERCENT CIEZ. Cr. (Dilatometric Investigations of the Transformation $\beta \rightarrow \alpha$ in U–0.4 Wt Percent Cr Alloy). Hofman, A. (Institute of Nuclear Research, Warsaw (Poland)). 1967. 19p. (In Polish). Dep.

Isothermal transformation $\beta \rightarrow \alpha$ of U–0.4 wt % Cr alloy at 640 to 400°C was investigated by the dilatometric method. The known kinetic equations were used for quantitative determination. The C-curve for the transformation was obtained. Activation energy for the process was calculated. The possibility of the existence of two C-curves at 640 to 400°C has been discussed. (auth)

23814 (INR–877/XIV/PS) PROBA SPRAWDZENIA ZAKRESU ROZPUSZCZALNOSCI Sn w Nb NA PRZYKLADZIE STOPU Nb–10 PERCENT Sn. (A Solubility Investigation of Sn in Nb in Nb–10 Percent Sn Alloys). Rutkowski, W.; Horubala, Z. (Institute of Nuclear Research, Warsaw (Poland)). 1967. 19p. (In Polish). Dep.

Metallography, radiography, and hardness were tested on alloys containing Nb + 10% Sn. The specimens were produced from powders by powder metallurgy. The alloy, a solid solution of Sn in Nb is investigated. The experiment results are in accord with previous investigations on Nb-Sn alloys and their phase-diagrams. (auth)

23815 USE OF MOESSBAUER EFFECTS IN METAL STUDIES. Bokshtein, B. S.; Voitkovskii, Yu. B.; Shvartsman, A. B. Zavod. Lab., 34: 34-41(1968). (In Russian).

A brief review is given on the use of resonance absorption of γ-quanta for resolving problems in metal studies. Measurements of magnetic spallation and chemical shift permit quantitative and qualitative phase identification in multi-phase systems. Moessbauer effects reveal the structural defects and atomic mobility in the metal. 43 references are included. (R.V.J.)

23816 CERIUM CRYSTALLINE STRUCTURE AT LOW TEMPERATURES. Pavlov, V. S.; Finkel, V. A. (Inst. of Physics and Tech., Kiev). Fiz. Metal. Metalloved., 24: 1123-6(Dec. 1967). (In Russian).

Equilibrate crystalline structure of high-purity cerium was studied at 90 to 300°K at atmospheric pressure. A graphic expression is given of the γ-Ce linear expansion factor as a function of temperature. The data obtained showed an abnormal characteristic of γ-Ce expansion in that with increased temperature the linear expansion factor diminished considerably. (R.V.J.)

23817 SMALL-ANGLE SCATTERING FROM DISLOCATION RINGS IN CRYSTALS, AND ITS RELATION TO THE DEPLETED ZONES IN NEUTRON-IRRADIATED METALS. Seeger, A.; Brand, P. (Max-Planck-Institut fuer Metallforschung, Stuttgart, Technische Hochschule, Stuttgart). pp 383-99 of Small-Angle X-Ray Scattering. Brumberger, H. (ed.). New York, Gordon and Breach, Science Publishers, Inc., 1967.

From Conference on Small-Angle X-Ray Scattering, Syracuse, N. Y. See CONF-650629.

Neutron irradiation of metals creates extended defects called depleted zones. Small-angle scattering of x rays or slow neutrons should be a powerful tool for studying the vacancy agglomerates in quenched or irradiated metals. Two models are given for the depleted zones, and the theory of small-angle scattering from edge-type dislocation rings is discussed in detail. Difficulties in the application of the theory to specific dislocation arrangements are considered, and a few selected results are presented for a circular edge-dislocation loop in Cu. (D.L.C.)

23818 CRYSTAL CHEMISTRY OF Au-RICH BINARY ALLOY PHASES WITH THE HEAVY RARE EARTHS. Sadagopan, V.; Giessen, B. C.; Grant, N. J. (Massachusetts Inst. of Tech., Cambridge). J. Less-Common Metals, 14: 279-90(Mar. 1968).

Using x-ray powder diffractometry, a comparative study was made of the binary alloy phases formed between Au and the rare-earth metals Nd, Sm, Gd, Dy, Ho, Er, and Yb, as well as with Y, covering the concentration range between rare earth (R.E.)Au_2 and Au. (R.E.)Au_2 phases of the $MoSi_2-CII_b$ type were found to exist from $GdAu_2$ to $YbAu_2$. (R.E.)Au_3 phases of the distorted $TiCu_3-Do_a$ type exist from $GdAu_3$ to $YbAu_3$ with strongly changing axial ratios. (R.E.)Au_4 phases with the $MoNi_4-DI_a$ type exist for $ErAu_4$ and $YbAu_4$. The atomic coordination relationships of all these phases are discussed. Y can be shown to act like a rare earth which is located near Dy; Yb is found to behave like a trivalent rare earth in these alloy phases. (auth)

23819 HIGH-TEMPERATURE LATTICE PARAMETERS OF $HoZn_2$. Michel, D. J.; Ryba, E. (Pennsylvania State Univ., University Park). J. Less-Common Metals, 14: 367-9(Mar. 1968). (NYO-3560-9).

The thermal behavior of $HoZn_2$ was studied by high-temperature x-ray powder diffractometry. Data on powder alloy specimens were recorded between room temperature and 800°C. Changes in lattice parameter with temperature indicate a continuously increasing expansion of the $HoZn_2$ structure along each principal direction. The behavior of each lattice parameter was approximately linear over the entire temperature range. (P.G.C.)

23820 INTERMETALLIC COMPOUNDS IN THE SYSTEM SAMARIUM–COBALT. Buschow, K. H. J.; Van der Goot, A. S. (Philips Research Labs., Eindhoven, Netherlands). J. Less-Common Metals, 14: 323-8(Mar. 1968).

The system samarium–cobalt has been studied over the whole concentration range. The following compounds were observed: Sm_3Co, Sm_5Co_4, $SmCo_2$, $SmCo_3$, Sm_2Co_7, $SmCo_5$, α-Sm_2Co_{17} and β-Sm_2Co_{17}. The lattice parameters for these compounds have been determined, and, with the exception of Sm_5Co_4, the structure type is given. Large homogeneity regions have been observed at higher temperatures for the compounds $SmCo_5$ and Sm_2Co_{17}. From the results of x-ray diffraction, thermoanalysis and metallography a tentative phase diagram has been constructed. (auth)

23821 RARE-EARTH INTERMEDIATE PHASES. VI. PSEUDO-BINARY SYSTEMS BETWEEN CUBIC LAVES PHASES FORMED BY RARE-EARTH METALS WITH IRON, COBALT, NICKEL, ALUMINIUM, AND RHODIUM. Mansey, R. C.; Raynor, G. V.; Harris, I. R. (Birmingham Univ., Eng.). J. Less-Common Metals, 14: 337-47(Mar. 1968).

The lattice spacings of the pseudo-binary systems formed between $CeFe_2$, $CeCo_2$ and $CeNi_2$ have been investigated. In these systems there is little difference in atomic size relationships so that deviations of the lattice spacing/composition curves from ideal behavior, as represented by the straight line joining the lattice spacings of the components, may be expected to indicate other factors of importance in these alloys. For comparison, the corresponding systems containing praseodymium and erbium in place of cerium were examined, and the systems $CeCo_2-CeRh_2$ and $CeAl_2-CeCo_2$ were included. In the latter system, mutual solubilities are limited and a phase of the C14 structure ($MgZn_2$-type) is formed at intermediate compositions. In the systems Pr $(Fe_{1-x}Co_x)_2$ and Pr $(Fe_{1-x}Ni_x)_2$ the cubic C15 structure is stable only above 0.5 mole fraction of $PrCo_2$ and above 0.85 mole fraction $PrNi_2$. In all other cases complete series of solid solutions are formed. Large negative deviations from ideal behavior are observed in the systems $CeFe_2-CeNi_2$ and $CeCl_2-CeNi_2$, and large positive deviations are shown in the $ErFe_2-ErCo_2$ and $ErFe_2-ErNi_2$ systems. In the other cases the deviations are small and positive. These effects are discussed and shown to be consistent with previous suggestions on the electronic configuration of cerium in the binary components; in $CeFe_2$ and $CeCo_2$ the cerium appears to adopt the 4-valent state, while in $CeNi_2$ the valency state probably does not correspond with total transfer of the 4f electron from the 4f shell of cerium. It is of particular interest to contrast the small deviations in the $PrCo_2-PrNi_2$ and $ErCo_2-ErNi_2$ systems, in which the valency state of the rare-earth metal is stable, with the large negative deviation in the $CeCo_2-CeNi_2$

system, for which the present results suggest that the valency state of cerium is a function of composition. (auth)

23822 RARE-EARTH INTERMEDIATE PHASES, V. THE CUBIC LAVES PHASES FORMED BY RARE-EARTH METALS WITH IRON AND NICKEL. Mansey, R. C.; Raynor, G. V.; Harris, I. R. (Birmingham Univ., Eng.). J. Less-Common Metals, 14: 329-36(Mar. 1968).

Lattice spacings have been determined at room temperature for the cubic (C15) Laves phases formed by rare-earth metals with iron, and with nickel, together with the variation of lattice spacing with temperature for $GdCo_2$. The results are briefly discussed and compared with previous work on $GdCo_2$. The results are briefly discussed and compared with previous work on $GdCo_2$. The results suggest that in $GdFe_2$ and $GdNi_2$ the gadolinium atoms have an abnormally small apparent atomic diameter, whereas in $GdCo_2$, the apparent atomic diameter of gadolinium corresponds with that of the pure metal. In $CeFe_2$, $CeCo_2$, and $CeNi_2$ the apparent atomic diameters of cerium are consistent with the complete or partial transfer of the 4f electrons of cerium to the conduction band. The elements samarium, neodymium and praseodymium appear to adopt expanded atomic diameters in the R.E. Ni_2 phases similar to those observed in the corresponding R.E. Al_2 and R.E. Pt_2 phases. (auth)

23823 WORKING PROPERTIES, PHASE EQUILIBRIUM, ELECTRICAL, AND SUPERCONDUCITIVITY PROPERTIES IN THE Nb–Ti–Zr SYSTEMS. Zwicker, U.; Meier, T.; Roeschel, E. (Univ., Erlangen, Ger. Forschungsinstitut fuer Edelmetalle und Metallchemie, Schwaebisch, Ger.). J. Less-Common Metals, 14: 253-68(Mar. 1968). (In German).

The isothermal section of the niobium–titanium–zirconium system at 900°C has been established for the alloys melted from metals of technical impurity. The miscibility gap extends to a composition of 51 at. % niobium and 19 at. % zirconium. The workability of niobium-rich niobium–zirconium alloys in the as-cast condition is considerably increased by the addition of titanium although the hardness also increases. The temperature coefficient of the electrical resistivity of the alloys investigated depends upon the valence-electron concentration. Alloys with a valence-electron concentration of about 4.2 show a negative temperature coefficient. There is an increase in the electrical conductivity of several alloys at cold reductions of 31% and 53%. The change in transition temperature due to cold-working and heat-treatment differs in the case of a 36 at. % Nb alloy from that in an alloy with about 20 at. % Nb. The critical current of Nb–Ti alloys with a valence-electron concentration of about 4.2 increases on addition of 7 at. % Zr but decreases on addition of 30 at. % or more of Zr. (auth)

23824 APPLICATION OF SMALL-ANGLE X-RAY SCATTERING TO PROBLEMS IN PHYSICAL METALLURGY AND METAL PHYSICS. Gerold, Volkmar (Max-Planck-Institute for Metal Research, Stuttgart). pp 277-317 of Small-Angle X-Ray Scattering. Brumberger, H. (ed.). New York, Gordon and Breach, Science Publishers, Inc., 1967.

From Conference on Small-Angle X-Ray Scattering, Syracuse, N. Y. See CONF-650629.

Despite the limitations of small-angle x-ray scattering, this method is used in physical metallurgy. The theoretical background of the method is given, and undesired diffraction effects are considered. Experimental results are reviewed for unstable solid solutions, vacancy clustering, and neutron diffraction of deformed metals. A bibliography of 69 references is included. (D.L.C.)

23825 ELECTRON MICROSCOPE INVESTIGATION OF CHROMIUM AND MOLYBDENUM DEFORMED UNDER HIGH PRESSURE. Martynov, E. D.; Trefilov, V. I.; Firstov, S. A.; Beresnev, B. I.; Ryabinin, Yu. N. (Inst. of Physics of the Earth, Moscow. Inst. of Physics of Metals, Kiev). Dokl. Akad. Nauk SSSR, 176: 1276-7(Oct. 21, 1967). (In Russian).

Cylindrical specimens of 99.99%-pure chromium and molybdenum were deformed by compression between two flat-parallel anvils, or by hydrostatic extrusion under a pressure of 16 to 18 kilobars. Deformation was done at 20 and 250°C in air at atmospheric pressure and in a liquid medium which was under a pressure of 14 to 18 kilobars. Electron microscope examination showed that foils prepared from specimens deformed at atmospheric pressure had a structure with a high density of dislocations which were uniformly distributed within the grain volume, i.e., a typical structure for cold-deformed metals. In contrast, the mean dislocation density in foils from specimens deformed at a high ambient pressure was substantially lower than that in foils from metals deformed at atmospheric pressure. The dislocation lines were noticeably straightened and dislocation tangles were few or hardly noticeable. The main mass of dislocations was rearranged into walls which formed a cellular substructure similar to a polygonization structure. The blocks formed under pressure were almost free of dislocations, had an elongated shape and were disoriented 8 to 12° relative to one another. The cellular structures formed with compression or hydrostatic extrusion were similar, regardless of the pressure, temperature or degree of deformation. The observed results showed that at high deformation pressures, the dislocation movement is intensified, although the activation mechanism is still not clear. It can be assumed that the plastification action of deformation under high pressure, in addition to other known factors, is associated with the formation of extremely fine grains on the basis of a strongly disoriented cellular structure. (ATD)

23826 ORDERED ARRANGEMENT OF OXYGEN IN THE INTERSTITIAL SOLID SOLUTION OF ZIRCONIUM–OXYGEN SYSTEM. Yamaguchi, Sadae (Tohoku Univ., Sendai). J. Phys. Soc. Jap., 24: 855-68(Apr. 1968).

The crystal structure of an interstitial solid solution of zirconium-oxygen system was investigated by means of x-ray, electron, and neutron diffraction on specimens in the composition range between 11 and 27 at. % O. The specimens were prepared by melting appropriate mixtures of zirconium metal and zirconium dioxide in an arc-furnace. In addition to a superstructure found by Holmberg and Dagerhamn in the composition $ZrO_y (0.33 < y < 0.40)$, a new superstructure having a different ordered arrangement of oxygen was found in the range of $ZrO_x (0.25 < x < 0.33)$. The atomic arrangement of oxygen in these superstructures can be expressed in terms of the stacking sequence of octahedral interstitial sites in the lattice of α-Zr, i.e., ABCABC ... and ABAB ... stackings in ZrO_x and ZrO_y respectively. However, the limiting composition $ZrO_{0.333}$ has an intermediate structure in which the arrangement of oxygen atoms is basically described as ABCBCACAB ... stacking with a nine layer period. The actual distribution of oxygen in specimens is not ideally regular as mentioned above, but contains a high degree of stacking disorder. (auth)

23827 STUDY OF THE OXIDATION OF NIOBIUM. Lainer, D. I.; Solov'ev, V. Ya.; Kuznetsova, M. I.; Krupnikova-Perlina, E. I.; Slesareva, E. N. Tr. Gos. Nauch.-Issled. Proekt. Inst. Splavov Obrab. Tsvet. Metal, No. 24, 75-85(1965). (In Russian).

Sodium-thermal Nb molten in arc and electron-beam furnaces was investigated. The kinetic oxidation curves at 600 to 1200°C were plotted from data on continuous weighing. Several kinetic laws could be observed for each temperature. At 500 to 800°C the scale consists of two layers of alpha Nb_2O_5. The lower layer adheres tightly to the metal and has a distinctly pronounced texture, but the upper layer peels off during cooling and has no texture. At temperatures exceeding 800°C alpha Nb_2O_5 changes into beta Nb_2O_5. The transformation is more complete in the upper layer of scale. The internal layer of scale is formed mainly as a result of the diffusion of the metal and the texture is one of growth. The absence of a structure in the upper layer of scale can be explained by the fact that the mechanism of its formation is not connected with the diffusion. (Rev. of Metal Lit.)

23828 THE NATURE OF THE TEMPERATURE ZONE OF BRITTLENESS IN HEAT-RESISTANT ALLOYS OF THE COPPER-NICKEL-BERYLLIUM SYSTEM. Portnoi, V. K.; Zakharov, M. V.; Novikov, I. I. Tr. Inst. Met. Obogashch. Akad. Nauk Kaz. SSR, No. 15, 47-56(1966). (In Russian).

Investigation was carried out on two Cu–NiBe alloys of the Cu–Ni–Be system with a content of 0.5 and 2.0 wt % NiBe. The mechanical and physical properties were investigated in the cast state and after rolling in the annealed, quenched and aged state. Tensile tests in atmospheric conditions and in a 3×10^{-4} mm Hg vacuum show that intercrystalline oxidation is not the main cause of the appearance of the temperature zone of brittleness at 400 to 800°C. The alloys have a strong tendency to form a supersaturated solid solution when cooled in air. Tensile tests of specimens cooled from the single-phase region to room temperature at 15,000-0.03°C/min and measurements of the electrical resistivity, the microhardness of the grain boundaries and of the grain center and the lattice parameter show that the plasticity dip in the Cu–Ni–Be alloys at 400 to 800°C in the cast and quenched state after rolling results from the decomposition of the solid solution. In the temperature zone of brittleness, the breakdown begins along the grain boundaries in connection with the decomposition in situ of the supersaturated solid solution. (Rev. Metal Lit.)

23829 APPLICATION OF IONIZING RADIATION TO STUDYING THE PROCESSES OF STRUCTURE FORMATION IN METALS. Drobyazin, V. N.; Konozenko, I. D.; Gorshkov, A. A. Dopov. Akad. Nauk Ukr. RSR, Ser. A, No. 1, 80-2(Jan. 1968). (In Russian).

The design of a device for studying the density of metals and alloys in the molten state or during crystallization using ionizing γ radiation is discussed. The curves for the density of Bi, Cd, and

Pb in the temperature range 20 to 450°C were analyzed. It was found that the use of ionizing radiation for studying structure formation in metals and alloys is very promising. (R.V.J.)

23830 DISLOCATION STRUCTURES IN NIOBIUM (COLUMBIUM) SINGLE CRYSTALS OBSERVED BY OPTICAL MICROSCOPY. Vardiman, R. G.; Achter, M. R. (Naval Research Lab., Washington, D. C.). Trans. Met. Soc. AIME, 242: 196-205(Feb. 1968).

Observations of dislocation structure in niobium are presented using two techniques. Triangular pits developed by electroetching are confined to orientations in the stereographic triangle between the {111} pole and planes of the ⟨111⟩ zone and require the presence of carbon. Some unusual electroetching phenomena at other orientations are noted. A chemical etch of dislocations decorated by the addition of carbon to 50 ppM reveals the complete dislocation line structure in a surface layer up to 30 μ deep, with a resolution of less than 1 μ. This effect is independent of surface orientation. The structure of subboundary nets may be resolved for misorientations up to about 1'. Dislocation structures found in strain anneal grown crystals, such as helices, prismatic loops, and high-density areas, are observed. The measurement of dislocation density is discussed and values obtained in different ways are compared. (auth)

23831 CONTRIBUTION TO THE STUDY OF THE EQUILIBRIUM DIAGRAMS OF TERNARY PHASES Cu–Nb–Ta. Frelin, C.; Desre, P.; Bonnier, E. (Ecole Nationale Superieure d'Electrochimie et d'Electrometallurgie, Grenoble, France). Rev. Int. Hautes Temp. Refract., 4: 261-8(Oct.-Dec. 1967). (In French).

The study of the ternary diagram Cu-Nb-Ta originated in research for a metallurgical separation Nb-Ta. The study at high temperatures of the ternary diagram Cu-Nb-Ta does not lead to a possibility of separation of Nb from Ta, but shows a gap of miscibility in the liquid state. The experimental technique used is a division method, which consists in separating the non-miscible phases by difference of density, and in analyzing them after solidification. (tr-auth)

23832 ELECTROCHEMICAL PROPERTIES AT HIGH TEMPERATURES OF THE SYSTEM ZIRCONIA–NEODYMIUM OXIDE. Guillou, M.; Millet, J.; Asquiedge, M.; Busson, N.; Jacquin, M.; Palous, S.; Pithon, M.; Lecante, A. (Electricite de France, Paris). Rev. Int. Hautes Temp. Refract., 4: 273-80(Oct.-Dec. 1967). (In French).

A physico-chemical study of the binary system Zirconia-Neodymium oxide has been done, the amount of stabilizing oxide being taken in the interval of 0 to 20 per 100 moles. The variation of the electrical conductivity as a function of the chemical potential of oxygen in the gaseous atmosphere surrounding the sample has been studied, and the ionic transport number has been determined. Crystallographic and dilatometric studies of the analyzed samples have been carried out simultaneously. For important amounts of Neodymium Oxide, corresponding to a complete stabilization of zirconia in its cubic form, as well as for little amounts, lower than those corresponding to any stabilization, the solid electrolyte of zirconia-neodymium oxide has a preponderant electric conduction. The analysis of the redox phenomena occurring during the electric flow at the contact between the electronic conductor and the binary oxide has been done. It seems that bringing a more reducible reagent than the solvent ZrO_2-Nd_2O_3, oxygen for example, to the interface between semiconducting oxide and metallic conductor, avoids the cathodic phenomenon of electrolysis. (tr-auth)

23833 STEREOGRAPHIC PROJECTION OF MONOCLINIC Zr. Boisot, M. P. (Centre de Recherches Metallurgiques de l'Ecole des Mines, Paris). J. Nucl. Mater., 25: 350-1(1968). (In French).

The angle between the crystallographic planes in monoclinic Zr were determined, and calculations were made for a standard stereographic projection. The values obtained are given. (J.S.R.)

23834 AN X-RAY DIFFRACTION STUDY OF THE DECOMPOSITION OF TUNGSTEN–CHROMIUM SOLID SOLUTION. Den Broeder, F. J. A. (Fundamenteel Onderzoek der Materie, Jutphaas, Netherlands); Burgers, W. G. Acta Met., 16: 265-8 (Mar. 1968).

X-ray diffraction studies showed that on decomposition of a Cr–W alloy in the vicinity of the chemical spinodal the matrix changed continuously in composition, whereas the segregated phase lay close to the equilibrium position. It was also observed that in the initial stages of decomposition of the alloy the precipitating W-rich phase had, at least partly, the same orientation as the matrix. On partial decomposition of the alloy, well within the chemical spinodal, the W-rich phase was inhomogeneous with an average composition far inside the miscibility gap. Satellite reflexions, which might be due to a spinodal decomposition mechanism were not detected. (P.G.C.)

23835 CONCERNING THE CRYSTAL STRUCTURE SEQUENCE IN THE LANTHANIDE METALS AND ALLOYS; EVIDENCE FOR 4f CONTRIBUTION TO THE BONDING. Gschneidner, K. A. Jr. (Iowa State Univ., Ames); Valletta, R. M. Acta Met., 16: 477-84(Mar. 1968).

The crystal structure sequence of the lanthanide metals when compressed or alloyed can be qualitatively explained by the participation of the 4f electrons in the bonding. A measure of this participation is given by the ratio of the metallic radius to the 4f radius. It is shown that the fcc phase is stable at radius ratio values less than 3.24, the dhcp phase between 3.28 and 3.54, the Sm structure (δ) between 3.60 and 3.65 and the hcp for values greater than 3.68. The crystal structure of Pm is predicted. The existence of these structures in the pure metals as a function of pressure and in lanthanide solid solution alloys is discussed. The possibility of a 4f contribution to the bonding in intermetallic compounds is discussed, and a test for showing whether or not this occurs in a morphotropic crystal structure series is proposed. (auth)

23836 DISLOCATION VELOCITY MEASUREMENTS IN HIGH PURITY MOLYBDENUM. Prekel, H. L. (Univ. of Pretoria). Lawley, A.; Conrad, H. Acta Met., 16: 337-45(Mar. 1968).

Dislocation velocities have been measured directly as a function of stress at 77 and 300°K in high purity molybdenum single crystals by the etch-pitting technique. The results are compared with data obtained from strain-rate change experiments at 77, 180, 300, and 575°K in the macrostrain region ($\epsilon > 10^{-3}$) and at 300°K in the microstrain region ($\epsilon \leq 10^{-3}$). All the experimental observations and the calculated deformation parameters (activation volume v^*, activation energy ΔH, kink energy H_k and stress exponent m) are shown shown to be self-consistent on the basis that dislocation mobility is controlled by the overcoming of Peierls–Nabarro hills by the nucleation of double kinks as proposed by Seeger. Thus v^* is found to be inversely proportional to τ^* with typical values of $v^* = 18b^3$ (at $\tau^* = 7$ kg mm^{-2}) and $v^* \approx 2000b^3$ (at $\tau^* = 0.055$ kg mm^{-2}) in the macro- and microstrain regions respectively at room temperature. Similarly $\Delta H = 1.57$ eV (at $\tau^* = 1$ kg mm^{-2}) and $H_k \approx 0.63$ eV. The experimentally measured dislocation velocity v is found to obey the equation, $v = (\tau^*/\tau_0)^m$ with $m \approx 6.4$ and $m \approx 23.0$ at 300°K and 77°K respectively. It is shown that this relation can be derived from the theory and that m is given by $m = H_k/4kT$. In accord with this relation the experimental values of m, as determined from dislocation velocity measurements and strain rate change experiments, are found to be inversely proportional to the absolute temperature T. The results also indicate that the same rate controlling mechanism is operative in both the micro- and macrostrain regions and that the usual assumption that the mobile dislocation density does not change during a rapid strain rate change is valid. (auth)

23837 FRICTION STRESS AND MEASUREMENTS MADE ON HYSTERESIS LOOPS OBSERVED IN THE MICROSTRAIN REGION. Bacon, D. J. (Atomic Energy Research Establishment, Harwell, Eng.). Acta Met., 16: 403-11(Mar. 1968).

Experimental observations indicate that the model of microstrain in which dislocation motion is opposed by a uniform friction stress is inadequate, and that the model should be refined to allow for an orientation-dependent friction stress. This cannot be done using the line tension approximation, but a computer method has been developed to allow the effect of a non-uniform stress on the bowing of a dislocation segment to be taken into account. Stress-strain curves for dislocations bowing against the Peierls–Nabarro friction stress are presented, and the ways in which this stress affects the dependence of the irreversible work done against friction on the plastic strain amplitude for dislocation sources of different orientations are described. The results are used to show flow curves of mechanical hysteresis-loop area vs loop width should vary with dislocation substructure, and the predictions are found to be in good agreement with experimental observations in a number of materials. Finally, the anelastic limit is shown to be associated with the stress at which the most-flexible Frank–Read source becomes unstable. (auth)

23838 RESISTIVITY STUDY OF STRAIN-AGEING IN Ta–O AND Nb–O. Koethe, A. (Deutsche Akademie der Wissenschaften zu Berlin, Dresden). Acta Met., 16: 357-67(Mar. 1968).

The isothermal strain-aging of oxygen-doped Nb and Ta was investigated by means of resistivity measurements. Samples used in the experiments were deformed by rolling at room temperature and aged in silicone oil at 140 to 200°C. The influences of temperature, degree of deformation, and effect of O_2 content were determined. It was shown that an inhomogeneity of dislocation distribution influenced strain-aging kinetics, and was also responsible

for deviations from Matthiessen's rule in that the observed decrease in resistance was smaller when measured at 293°K than at low temperatures. The dislocation contribution to resistivity in Ta was estimated to be about 6×10^{-13} $\mu\Omega cm^3$. Evidence was given for existence of equilibrium Cottrell atmospheres. At 140 to 200°C the number of O_2 atoms bound to dislocations varied linearly with I/T for samples containing about 160 ppM O_2. Measurements on aged samples deformed a second time were in agreement with Hahn's theory of the yield point. (auth)

23839 ROOM TEMPERATURE SLIP AND YIELDING IN NIOBIUM SINGLE CRYSTALS. Votava, E. (Union Carbide European Research Associates, Brussels). Acta Met., 16: 285-90(Mar. 1968).

The room temperature slip, the operative glide planes and the mechanism of deformation of Nb single crystals with the approximate orientation ⟨123⟩ was investigated. It was found that between the upper and lower yield point and also in the easy glide range slip takes place on {101}-primary and {1$\bar{1}$0}-secondary slip planes with a common ⟨111⟩-slip direction. From slip line observations around the single crystals it is concluded that edge dislocations move over larger distances than screw dislocations. The development of the secondary {1$\bar{1}$0} ⟨111⟩-glide system is attributed to a higher stress which exists when a marked yield point is present and to cooperative source operation by dislocation arrays on the primary glide system. However, double cross-slip over large distances cannot be excluded completely. (auth)

23840 MODIFIED CARBIDE FUELS. Jordan, Kenneth R. (to Westinghouse Electric Corp.). U. S. Patent 3,347,749. Oct. 17, 1967. Filed Sept. 7, 1965.

A modified carbide fuel is developed which avoids possible cladding–fuel incompatibility (embrittlement by excess carbon, or eutectic formation by excess uranium). The modified fuel contains added chromium which reacts with excess carbon to form stable carbides, particularly $Cr_{23}C_6$. In the case of carbon deficiency, chromium carbide is added. A typical modified carbide fuel composition is 4.56 to 4.85% C, 0.40 to 5.17% Cr, and balance U, Pu, and/or Th. The fuel may be canned in a steel tube with liquid metal in the clearance. (D.L.C.)

Radiation Effects

Refer also to abstracts 24375 and 25145.

23841 (BARC-300) RADIATION DAMAGE STUDIES ON Zr–0.5 PERCENT Nb–1 PERCENT Cr ALLOY. Ray, S.; Sharma, B. D. (Bhabha Atomic Research Centre, Bombay (India)). 1967. 24p. Dep.

Reported is the effect of neutron irradiation up to an integrated dose of 1.6×10^{19} n/cm² (thermal) on the tensile properties of Zr–0.5% Nb–1% Cr in annealed, cold-worked and as-quenched states. The irradiation was carried out in Apsara at 50°C. The studies reveal that whereas the cold-worked and as-quenched alloy does not exhibit any significant hardening, in the annealed states ultimate tensile strength and 0.2% yield strength increase by 100% and 66% respectively for a dose of 1.25×10^{19} nvt. Isochronal and isothermal recovery studies further reveal that the irradiation-induced damage anneals out at 175 to 410°C with an activation energy of 1.5 eV. The temperature and neutron flux dependence of 0.2% yield strength of irradiated alloy shows that hardening could be attributed to irradiation-induced depleted zones, as suggested by Seeger. (auth)

23842 (BMI-1834) EFFECTS OF LARGE FAST FLUENCES ON MECHANICAL PROPERTIES OF TYPE 347 STAINLESS STEEL AND ALUMINUM. Kangilaski, Mihkel; Shober, Frederic R.; DeMastry, John A.; Gates, John E. (Battelle Memorial Inst., Columbus, Ohio). Mar. 27, 1968. Contract W-7405-eng-92. 36p. Dep. CFSTI.

Changes in mechanical properties of type 347 stainless steel, irradiated at about 50°C, were determined after fast fluences (>1 MeV) from 5.5×10^{21} to 21×10^{21} n/cm². Tensile tests were performed at room temperature, 316, and 750°C. At room temperature and 316°C the yield and tensile strengths are increased, with the ratio of yield strength to ultimate strength being nearly unity. Increases in strength saturated after a fast fluence of 5.5×10^{21} n/cm². A decrease of room-temperature ductility saturated after a fast fluence of 5.5×10^{21} n/cm²; however, at 316°C ductility decreased up to 21×10^{21} n/cm². Annealing at 982°C for 1 hr completely restored preirradiation mechanical properties at room temperature and 316°C, except for a 10% decrease in ductility. At room temperature and 316°C, fracture is transgranular, while at 750°C fracture is intergranular. At 750°C after a fast fluence of 21×10^{21} n/cm², elongation was reduced from the normal 26% to 0.5%. Annealing for 1 hr at 982 or 1350°C decreased strength and did not improve the as-irradiated ductility. Testing of irradiation Charpy V-notch specimens indicated that irradiation reduced the impact strength of type 347 stainless steel at −196°C and room temperature, but had no effect on the impact strength at 316°C. Irradiation of type 347 stainless steel specimens to 5.5×10^{21} n/cm² decreased the fatigue life for total strains higher than 1.3% per cycle, but did not significantly affect the fatigue life for total strains less than 1.3% per cycle. After fast fluences of 11×10^{21} and 16×10^{21} n/cm², the fatigue life at high total strains was comparable to that of unirradiated stainless steel. However, at low total strains (<1.3%) fatigue life was considerably improved by a fast fluence of 11×10^{21} n/cm². Irradiation of 1100 aluminum to fast fluences of about 10×10^{21} n/cm², and erosion in the ETR environment at 50°C, increased room-temperature yield strength from about 4500 to 50,000 psi, and reduced elongation from 30 to 40% to as little as 3%. (auth)

23843 (IN-1131, pp 37-55) RADIATION EFFECTS ON DISPERSION FUELS. (Idaho Nuclear Corp., Idaho Falls).

A comparison of the reactor performance using commercially manufactured U_3O_8 and ORNL-produced U_3O_8 was performed. The blister resistance of various aluminum dispersion fuel systems is discussed. Graphical representations for blister resistance data are given for $UAl_3 + B_4C$ dispersed in aluminum, UO_2 dispersed in aluminum, and U_3O_8 dispersed in aluminum. Eight samples of irradiated stainless steel-clad urania fuel plates were examined by microprobe and burnups determined. (J.C.W.)

23844 (IN-1131, pp 56-82) IRRADIATION OF FULL SIZE REACTOR FUEL ELEMENTS. (Idaho Nuclear Corp., Idaho Falls).

Tests of 700 MTR and ETR fuel assemblies made with powdered uranium-aluminide show satisfactory results. The fuel element life in the ETR has increased. Fuel elements using cores made by powder metallurgy techniques have operated successfully in all reactor core positions. Prototype testing of ETR fuel elements using B_4C + Al foils in fuel plates is summarized. Investigations of failures in TRA fuel elements are discussed. (J.C.W.)

23845 (IN-1131, pp 83-90) RADIATION EFFECTS ON STRUCTURAL MATERIALS. (Idaho Nuclear Corp., Idaho Falls).

The performance of zircaloy-2 in-pile tubes with ultra-high radiation exposure was tested in ETR. The post-irradiation examination included as-irradiated metallography, metallography (after heat treating) for hydride precipitation, hydrogen gas analysis, burst testing, and tensile testing all as a function of vertical location in the reactor or as a function of neutron fluence. One tube is being tested further to a fluence of 9 to 12×10^{21} n/cm² (>MeV). An artificial defect was machined in PM-2A pressure vessel wall and the vessel was subjected to high internal pressurization. A number of repetitions of this treatment, with the size of the defect being increased each time, did not lead to failure. Subsequently the second of two treatments of the defect region with hot 1 to 1 HCl to produce stress corrosion finally led to failure under pressure. Characterization of the fracture and estimation of the percentage of brittle fracture were determined. (J.C.W.)

23846 (ORNL-TM-2127) STRETCH: A COMPUTER PROGRAM FOR PREDICTING COATED-PARTICLE IRRADIATION BEHAVIOR; MODIFICATION IV, DECEMBER 1967. Prados, J. W.; Godfrey, T. G. (Oak Ridge National Lab., Tenn.). Apr. 1968. Contract W-7405-eng-26. 55p. Dep. CFSTI.

A computer program for calculating the expected operating lifetimes of pyrolytic-carbon-coated fuel microspheres under irradiation is described. The coating consists of a porous inner layer, which provides volume for fuel swelling and fission-gas release, and a high-density outer layer which serves as a pressure vessel. Anisotropic mechanical behavior and irradiation creep in the outer pyrolytic-carbon coating can be taken into account in the calculations. A listing of the FORTRAN IV source program, instructions for supplying input data, and sample output data are provided. (auth)

23847 (AERE-Trans-1093) INFLUENCE OF REACTOR IRRADIATION ON THE PHASE COMPOSITION OF URANIUM CONTAINING SMALL QUANTITIES OF ALLOYING ELEMENTS. Konobeevskii, S. T.; Sokurskii, Yu. N.; Bobkov, Yu. V.; Dubrovin, K. P.; Protsenko, L. N. Translated by J. E. Baker for Atomic Energy Research Establishment, Harwell, Eng., from At. Energ. (USSR), 22: 450-9(1967). 20p. Dep. CFSTI. UK 2s. 6d. JCL $1.60 fs, $0.80 mf.

The effect of reactor irradiation on the electrical resistivity of binary alloys of uranium with small quantities of iron, aluminum and silicon is described. The alloys were irradiated after quenching from the γ-phase, and also after γ-quenching and tempering in the α-phase. It was found that the electrical resistivity of binary

alloys tempered in the α-region increases sharply as a result of irradiation doses up to ~10^{18} neutrons/cm^2. At doses >10^{18} neutrons/cm^2 the rise in resistance is less rapid. The electrical resistance of quenched alloys rises a little at first, but then decreases. These changes in resistance are connected with phase transitions which occur in the alloys as a result of irradiation. It was established that irradiation of α-tempered alloys gives rise to solution of finely divided inclusions and to transformation of the alloying addition into a solid solution; in γ-quenched alloys it stimulates breakdown of metastable solid solutions. The influence of annealing on the electrical resistivity of irradiated specimens was also investigated. (auth)

23848 RADIATION EFFECTS IN METALLIC MATERIALS. Bystrov, L. N.; Ivanov, L. I. Fiz. Khim. Obrab. Mater., No. 1, 17-26(Jan.-Feb. 1967). (In Russian).

Mechanisms of the effect of high-energy radiation on the mechanical properties of metallic materials are considered from the aspect of using radiation treatment for a directional change in metal and alloy properties. Mechanisms considered include the direct interaction of radiation defects with dislocations; nuclear alloying; the radiation stimulation of crystallochemical processes, such as the decomposition of supersaturated solid solutions, ordering of alloys, phase transformations, and relief of internal stresses. The latter mechanism is the most promising for bringing about stable changes in metals. It is suggested that particular attention be given to processes which cannot in principle be realized by other methods, such as heat or mechanical treatment. An investigation of the effect of 2.5 MeV electron radiation on the mechanical properties of type 40Kh5SNEM steel subjected to low-temperature thermomechanical treatment is described. The type of radiation to use is also considered. Electron radiation is considered most promising for radiation hardening, while gamma irradiation is irreplaceable in some cases, such as when massive parts have to be irradiated. (JPRS)

23849 LOW-ENERGY IRRADIATION OF GERMANIUM SINGLE CRYSTALS BY He^+ AND Xe^+ INERT GAS IONS. Tishchenko, V. D. (Kiev State Univ.). Fiz. Tekh. Poluprov., 1: 1577-9(1967). (In Russian).

An experimental investigation was made of the characteristics of structural damage to the faces of Ge single crystals by low-energy He^+ and Xe^+ ion bombardment. One of the faces of a cube-form target was subjected to a flux of bombarding ions. The pressure of residual gases in the sealed-off glass tube was about 5×10^{-9} torr after the admission of the pure inert gas which served as the ion source. Radioactive indicators were used to measure the material separated from the surface of the target. The activation of the targets by the ^{71}Ge isotope was carried out by neutron flux. The yield of germanium atoms knocked out of the [111] face by the inert gas ions of varying energy (from about 50 eV down to 5 eV) shows two parts of differing steepness, the steeper part corresponding to higher energies. At a constant energy (21 eV) of Xe^+ ions directed onto the [100] and [110] faces, a considerable drop of the yield in time was observed, which started to level off after about 40 min of irradiation. The yield drop was much more pronounced on the [110] face. Markedly different yield characteristics were obtained when the ion energy was varied upward under good vacuum conditions and after a careful heat treatment of the specimens. Here, the yield as a function of ion energy acquired linearity and a constant steepness which makes it possible to judge the break-off energy of the atoms under bombardment by a given type of ions. As a function of time, the yield under these conditions remained practically constant. The observed facts should cause a reevaluation of known experimental data concerning the atom yield of certain substances, especially under fluxes of low- and medium-energy ions. (ATD)

23850 PRE-PRECIPITATION RATE IN Al–10 PERCENT Zn ALLOY NEUTRON IRRADIATED AT 78°K. Horak, J. A. (Argonne National Lab., Ill.). Phil. Mag., 17: 643-6(Mar. 1968).

An examination of the analysis by Schüle concerning the enhanced Guinier–Preston zone formation, observed in Al–4.4 at. % Zn after neutron irradiation at 78°K was made. Schüle concluded that the vacancy concentration after irradiation was insufficient to account for the enhanced zone formation and that interstitials were responsible for the enhancement. The result of the examination, which utilizes the actual numerical values of the C-F-P experiment, reveals that the vacancy concentration after the irradiation was more than adequate to account for the observed G.P. zone formation. In addition, the enhanced zone formation after the irradiation at 78°K by C-F-P, and after fast neutron irradiation of Al–Zn alloys at 4.5°K are in agreement with the enhanced zoned formation observed in quenching experiments. Therefore, it is proposed that the motion of vacancies is responsible for the enhanced G.P. zone formation after irradiation as well as after quenching. (auth)

23851 PLATELETS OF INTERSTITIAL ATOMS IN PROTON-IRRADIATED COPPER. Mazey, D. J.; Barnes, R. S. (Atomic Energy Research Establishment, Harwell, Eng.). Phil. Mag., 17: 387-403(Feb. 1968). (AERE-R-5525).

Regular hexagonal dislocation loops containing stacking faults form within thin films of copper during bombardment with protons in the energy range 20 to 60 keV, but only when the film temperature lies between about 70°C and 300°C. Analysis of these loops in the electron microscope reveals that they are of the Frank sessile type with ⟨110⟩ edges and lying on {111} planes. The stacking faults are extrinsic, suggesting that the loops are caused by clusters of interstitial atoms. Double-faulted loops are also observed. It is concluded that the presence of hydrogen influenced the formation of faulted loops under the conditions of the ion bombardment. (auth)

Ceramics and Cermets

Refer also to abstracts 23707, 23711, 23712, and 25061.

23852 (CEA-R-3353) REACTION DES CARBURES D'URANIUM ET DE PLUTONIUM AVEC DES ACIERS AUSTENITIQUES. (Reaction of Carbides of Uranium and Plutonium with Austenitic Steels). Mouchnino, Michel (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Oct. 1967. 35p. (In French). Dep.

The reaction of uranium and plutonium carbides with austenitic steels has been studied between 650 and 1050°C using UC/steel, and (UPu)C/steel diffusion couples. The steels are of the type CN 18.10 with or without addition of molybdenum. The carbides used are hyper-stoichiometric. Tests were also carried out with UCTi, UCMo, UPuCTi, and UPuCMo. Up to 800°C no marked diffusion of carbon into stainless steel is observed. Between 800 and 900°C the carbon produced by the decomposition of the higher carbides diffuses into the steel. Above 900°C, decomposition of the monocarbide occurs according to a reaction which can be written as: (U,PuC) + (Fe, Ni, Cr) → (U, Pu) Fe_2 + $Cr_{23}C_6$. Above 950°C the behavior of UPuCMo and that of the titanium (CN 18.12) and nickel (NC 38.18) steels is observed to be very satisfactory. (auth)

23853 (CONF-660524–, pp 273-92) DEVELOPMENT OF COATED-PARTICLE FUELS FOR ADVANCED GAS-COOLED REACTORS. Prados, J. W.; Beatty, R. L.; Beutler, H.; Coobs, J. H.; Olsen, A. R.; Scott, J. L. (Oak Ridge National Lab., Tenn.).

Theoretical considerations and early irradiation-test results indicated that long-term coated-particle irradiation stability would be enhanced by provision of at least two coating layers surrounding the fuel particle: a high-density outer layer for primary fission-product containment and a low-density inner layer to protect the outer layer from fission-fragment bombardment and to furnish space for fission-gas accumulation and fuel-particle expansion. Techniques were developed for depositing such coating layers on both carbide and oxide particles in fluidized beds by using methane or acetylene as the source of carbon. The control of coating properties by independently varying the principal fabrication parameters was investigated systematically. Also, a mathematical model was developed for predicting when the coatings of fueled microspheres would be expected to fail under irradiation. The irradiation-test phase of the program has employed both unsupported coated particles and fueled-graphite elements containing coated particles. Results are now available for several lots of well-characterized coated particles irradiated in static and sweep capsules. Comparisons of results from these tests with mathematical-model failure predictions have been most encouraging. (auth)

Preparation and Fabrication

Refer also to abstracts 22991, 23730, 23745, 23747, and 25157.

23854 (CONF-660524–, pp 157-84) RECYCLE OF THORIUM FUEL FOR HEAVY-WATER-MODERATED ORGANIC-COOLED REACTORS. Moncrief, E. C.; Schileo, G. (Babcock and Wilcox Co., Lynchburg, Va. Research and Development Div.).

Fuel processing costs were evaluated for two of the more promising heavy-water-moderated organic-cooled reactor (HWOCR) fuels: ThO_2–UO_2 and Th–U alloy. The costs for reprocessing, conversion, fabrication, and waste disposal ranged from $62 to $79 per kilogram for oxide cores at conceptual plant capacities of 2.2 to 2.6 metric tons/day and from $43 to $78 per kilogram for alloy cores at capacities of 2.2 to 5.7 metric tons/day. The costs were based on a hypothetical 15,000-MW(e) HWOCR economy that used both thorium and uranium recycled in the heavily shielded, remotely operated Thorium Recycle Integrated Plant (TRIP). Capital costs for the TRIP facility were

about $70 million for oxide-core fabrication and from $80 to $100 million for alloy fabrication, depending on the fuel design. Annual operating costs were $40 to $50 million for oxide cores and $50 to $65 million for alloy cores. Oxide processing included a single-cycle acid-thorex extraction, feed-material conversion by the sol-gel process, and refabrication by vibratory compaction. The alloy-processing scheme likewise included the single-cycle extraction operation but used a calcium-reduction flow sheet for thorium-metal preparation and a coextrusion flow sheet for alloy refabrication. (auth)

23855 (CONF-660524–, pp 293-8) THORIUM HIGH TEMPERATURE REACTOR PROJECT FUEL DEVELOPMENT PROGRAM. Stoecker, H. J. (Kernforschungsanlage, Juelich (West Germany)).

The fuel element for the Thorium High Temperature Reactor (THTR) is similar to the element of the AVR pebble-bed reactor, i.e., graphite balls of 6 cm in diameter which contain the fuel in the form of coated particles. Several types of fuel elements for the THTR are under investigation. Each of the four main types of elements (hollow sphere, pressed, annular gap, and spherical gap) possess special advantages. The fuel particles, both oxide and carbide, are prepared either by powder metallurgy or by a chemical method that differs from the usual sol-gel process in that there is an inner gelling of the sol droplets. About 35 different combinations of coatings were prepared in a fluidized bed, mostly with low-density inner and high-density outer coatings. (auth)

23856 (CONF-660524–, pp 377-90) SOL-GEL PROCESSES FOR THE PREPARATION OF SPHERICAL THORIUM-CONTAINING FUEL PARTICLES. van der Brugghen, F. W.; Hermans, M. E. A.; Kanij, J. B. W.; Noothout, A. J.; van der Plas, Th.; Slooten, H. S. G. (Keuring van Electrotechnische Materialen, N. V., Arnhem (Netherlands)).

The gelling of a sol droplet in an emulsion of the water-in-oil type is ideally suited for a production method of spherical fuel particles, especially when the easy-gelling thorium hydroxide is present. The size control of the droplets, the gelling conditions, and the washing procedure form the most critical steps in the process. In the KEMA process, which was developed for 5-mμ UO_2–ThO_2 fuel spheres, thorium hydroxide is precipitated from a thorium nitrate solution; the precipitate is freed of most of the residual electrolyte and peptized into an aqueous sol. This sol is thereafter dispersed in an organic phase. In this step a stirrer with a high shear rate controls the very small size of the droplets. Gelling of the sol droplets is effected by reaction with ammonia. The resulting gel spheres are dried, filtered, washed, and calcined. For larger fuel spheres, between 100 and 1000 mμ, the external gelling of the sol by ammonia is less well suited. In this case, internal gelling by ammonia donor that has been mixed with the sol previous to emulsification yields good results. The process can be carried out both at a high temperature (90 to 100°C) and at a relatively low temperature (40 to 50°C). In the washing step, cracking and peeling of the gelled particles were often observed. It was shown that these effects were caused by osmotic phenomena, and, accordingly, suitable measures could be developed to prevent cracking and peeling. The processes considered are also applicable for the preparation of carbide spheres. (auth)

23857 (CONF-660524–, pp 417-43) DIRECT PREPARATION OF ThO_2–$^{233}UO_2$ FUEL BY THE SOL-GEL PROCESS. Kosiancic, E. J.; Dodd, R. H.; Halva, C. J. (Babcock and Wilcox Co., Lynchburg, Va. Research and Development Div.).

An unshielded direct-fabrication glove-box line for the preparation of ThO_2–$^{233}UO_2$ reactor feed material was designed and operated. The pilot plant was designed to incorporate several features: optimized process batch sizes within the limits of radiation hazard and criticality, minimized system holdup, simplified equipment and equipment maintenance, minimized elapsed fabrication time, and improved personnel training to minimize direct handling of fuel materials. These features are all essential for processing ^{233}U immediately after daughter removal and before regrowth of daughter activity. The pilot plant has been used for 61 denitrations to process 632 kg of thoria. After optimization to variations, the desired NO_3^- to thorium ratios (from 0.01 to 0.06) were easily obtained. Thoria (62 kg) and thoria–urania (473 kg) fuel were routinely prepared. Concurrently with cold sol-gel work, the deactivation of ^{233}U nitrate solutions by cation exchange was investigated. Thoria–3% urania was prepared from stock ^{233}U solution. The typical sol-gel run time was two days. Radiation dosage received by personnel was carefully monitored. (auth)

23858 (CONF-660524–, pp 537-45) DIRECT FABRICATION OF ^{233}U FUEL ELEMENTS. Kerr, J. M.; Barnes, L. D.; Ryon, J. W. (Babcock and Wilcox Co., Lynchburg, Va. Research and Development Div.).

Uranium-233 fuel material was fabricated into full-sized fuel rods, which were remotely assembled into a fuel element under water. This direct-fabrication method used unshielded glove boxes in which the tubes were loaded with powder fuel by vibratory compaction. By use of rapid and clean fabrication methods in a well-designed facility, all stages of the fabrication process were carried out before the buildup of the gamma-emitting daughters required the use of heavy shielding. After the fuel rods had been fabricated, inspected, and cleaned, they were stored under water for subsequent assembly into a fuel element. The successful completion of this program indicates that ^{233}U-containing fuel rods can be fabricated by direct-handling methods without excessive radiation doses to personnel. (auth)

23859 (IN–1131, pp 127-39) UTILIZATION OF THE G-12 LOOP AS A FAST FLUX TEST FACILITY. (Idaho Nuclear Corp., Idaho Falls).

Designs are given for two fuel elements. Design 1 consists of ten 0.250-inch-OD clad fuel pins, each surrounded by a 0.040-inch coolant annulus. The pins are dispersed in a nickel 8 wt % Eu_2O_3 matrix. Design 2 contains fourteen 0.250-inch-OD fuel pins also dispersed in 8 wt % Eu_2O_3–nickel matrix. The 3 central pins are surrounded by a 0.060-inch coolant annulus with the remaining 11 pins arranged in an outer annular ring. FOG, a one-dimensional neutron diffusion code which yields relative flux and power density values, is limited to a maximum of 4 energy groups and 40 homogenized regions. Three fast and one thermal energy groups were used. The results of the FOG code computer mockup and the fast test assembly are recorded. (J.C.W.)

23860 (ORNL-TM-2128) PREPARATION OF SOLS AND MICROSPHERES OF ThO_2, UO_2, ThO_2–UO_2, AND ThO_2–UO_3 BY SOL-GEL TECHNIQUES. Meservey, A. B. (Oak Ridge National Lab., Tenn.). Feb. 6, 1968. Contract W-7405-eng-26. 44p. Dep. CFSTI.

A method was developed for preparing ThO_2–25 mole % UO_3 sols of low nitrate content by coprecipitation of thorium–uranium (VI) hydroxide from thorium–uranyl nitrate solution. Large (up to at least 500 μ in diameter) gel microspheres that exhibited no cracks could be formed in 2-ethyl-1-hexanol and fired to 1200°C in air followed by hydrogen. The fired microspheres had densities that were 99.5% of theoretical, and a high resistance to crushing (about 2 kg). Another approach, boiling UO_3 with ThO_2 sols made from $Th(OH)_4$, was also used to prepare ThO_2–25 mole % UO_3 sols. The coprecipitation method was successful for preparing stable ThO_2–UO_2 sols with widely varied thorium : uranium atom ratios. For production purposes, ThO_2–UO_3 sols are prepared by blending ThO_2 sols with UO_3 sols. The preparation of pure UO_2 sol by peptization of precipitated $U(OH)_4$ with HNO_3 was proved to be feasible; the preparation of UO_2 sol and "clay" by acetate routes showed promise. Microspheres without cracks were formed from pure precipitated–thoria sols, and a new type of thoria "clay" that is suitable for extrusion and firing to ceramic bodies was made from steam-denitrated thoria. (auth)

23861 COMPACTNESS EFFECT OF BRIQUETTES COMPRESSED OF ZIRCONIUM CARBIDE ON COMPACTNESS OF SINTERED SAMPLES. Nezhevenko, L. B.; Gurevich, B. D.; Groshev, V. I.; Bokov, O. V. Porosh. Met., Akad. Nauk Ukr. SSR, No. 1, 14-16(Jan. 1968). (In Russian).

The effects of initial compacting of green ZrC briquettes on the density of the sintered compacts is discussed. Zirconium carbide powders having various types of external and internal surfaces were compacted and sintered. It was found that the compactness effect of green briquettes on sintered density can be quantitatively estimated when coarse powders of low activity are used but that if finely dispersed powders, which noticeably affect the sintering process are used a quantitative estimation of the effect is practically impossible. (P.G.C.)

23862 SINTERING IN GAS DISCHARGES. Bennett, C. E. G.; McKinnon, N. A.; Williams, L. S. (CSIRO, Melbourne). Nature (London), 217: 1287-8(Mar. 30, 1968).

A study is described of the application of a microwave-stimulated electrodeless gas discharge to the sintering of various ceramics, metals, etc., with particular emphasis on refractory oxides, including Al_2O_3, BeO, HfO_2, MgO, and ThO_2. Some results unusual in comparison with conventional heating methods were obtained. The apparatus used is described, together with variants in its method of operation. For Al_2O_3 a very marked increase in rate of densification was observed. With regard to mechanical strength, it was found that while the average strength of the sintered specimens passed through a maximum and then decreased slightly as high densities were reached, this effect was not nearly so marked as for conventionally sintered specimens of the same densities. This difference in behavior can at least in part be attributed to the much smaller grain size in discharge-sintered

specimens. There is also the possibility that cleaner grain boundaries, with fewer mechanical imperfections, may contribute to the higher strength. The nature of the sintering atmosphere influences only the efficiency of heating. A moderately coarse grade of HfO_2, of nominal size 8 μ, sintered to 90.3% theoretical density in 25 min at 1525 to 1550°C in an air glow discharge, whereas similar specimens treated in a normal furnace required a temperature of 1700°C to reach 87.5% density in the same time. Explanations are advanced to explain the observed rapid densification. (UK)

23863 PRODUCTION OF MIXED-CARBIDES BY AUXILLIARY-METAL-BATH. Jangg, G.; Kieffer, R.; Usner, L. (Technische Hochschule, Vienna). J. Less-Common Metals, 14: 269-77(Mar. 1968). (In German).

The auxiliary-metal-bath technique, using Al or Co, already introduced for the production of pure carbides, is also suitable for the production of solid solutions of carbides. The resulting solid solutions are pure—low in oxygen and nitrogen—and well crystallized. Under the most favorable working conditions of miscibility, gaps have been observed at low temperatures in carbide systems that up to now have been considered as completely miscible. (auth)

23864 SEPARATION OF NIOBIUM AND TANTALUM BY REACTION OF THE METAL PENTACHLORIDES WITH CALCIUM OXIDE AND CALCIUM FLUORIDE. Conway, J. E.; Stevenson, F. D. (Ames Lab., Iowa). J. Less-Common Metals, 14: 303-13 (Mar. 1968). (IS-1646).

A study of the reactions of the gaseous pentachlorides of niobium and tantalum with calcium fluoride, calcium oxide, and calcium fluoride coated with calcium oxide showed that niobium could not be separated from tantalum merely by reaction of the mixed pentachlorides with pure calcium fluoride. Each of the pentachlorides reacted at nearly equal rates to form non-volatile compounds. However, it was found that a mixture of the pentachlorides could be separated by reaction with calcium fluoride coated with calcium oxide. A volatile niobium product containing less than 0.02% tantalum from an initial 50 wt % mixture resulted with a yield of 75% of the niobium fed. The separation is attributed to differences in the stabilities of the oxytrichlorides of niobium and tantalum. The oxytrichlorides are formed by reaction of the pentachlorides with calcium oxide; the tantalum oxychloride is unstable and quickly decomposes to the non-volatile oxide. Niobium oxytrichloride, however, is relatively stable and does not react at a significant rate with the surface calcium oxide. The yield of niobium was increased to more than 90% with no loss in purity by initially reacting the mixed pentachlorides with calcium oxide to provide a niobium oxytrichloride-rich feed to the calcium oxide-coated calcium fluoride. (auth)

23865 REACTION BETWEEN IRON AND ZIRCONIA AT HIGH TEMPERATURES. Becherescu, D.; Winter, Fr.; Cicoare, L. Bul. Stiint. Teh. Inst. Politeh. Timisoara, 12: No. 1, 37 (1967). (In Rumanian).

Mixtures of ZrO_2 and Fe were fired in an argon plasma, quenched and examined. Fe reacts with ZrO_2 to form FeO, which forms Fe_3O_4 and Fe, the latter then reacting with more ZrO_2. (Brit. Ceram. Abstr.)

23866 SINTERING OF BERYLLIA. II. HOT PRESSING OF BERYLLIA POWDERS OF DIFFERENT ORIGINS AND THERMAL TREATMENTS. Moorthy, V. K.; Kamath, G. T.; Bahl, J. K. Trans. Indian Ceram. Soc., 26: No. 2, 19(1967).

BeO of high density and controlled microstructure is necessary for application as moderator in various reactor systems. Normally, high-density BeO is prepared by above 1700°. The sintering behavior, either in cold pressing and sintering or in hot pressing, is influenced by the powder characteristics of the raw material. In this investigation, the sintering behavior during hot pressing of BeO powders of divergent characteristics (i.e., prepared from different compounds and subjected to different calcination treatments) has been studied. Powders derived from the sulfate by calcination at 750° attained a densification of over 99% theoretical density (2.99 g/cm³; theoretical density 3.01 g/cm³) at 1400°C. Attainment of densification at lower temperature results in little grain development and thus offers the chance to obtain samples sintered to a high density and controlled microstructure. Attempts are made to relate the densification behavior and microstructure development to the characteristics of the raw powders. (Brit. Ceram. Abstr.)

23867 RESEARCH INTO THE TECHNOLOGICAL PROCESS OF URANIUM DIOXIDE PRODUCTION BY ELECTROCHEMICAL REDUCTION. Maljkovic, Darko (Sisku Tehnoloskog, Zagreb); Branica, Marko. Nukl. Energ., 5: No. 4, 1-6(1967). (In Slovak).

A pilot plant was built for testing the production of uranium dioxide by a process that includes the electrochemical reduction of carbonate melts of uranium (VI) on a rotating mercury electrode. Results of test operation of the plant and the basic technological and economic parameters of the process during the processing of nuclear pure ammonium-diuranate (ADU) into wet uranium dioxide are presented. During a continuous-discontinuous round-the-clock operation the plant is capable of processing about 14 kg of uranium into uranium dioxide, which corresponds to processing of about 3500 kg of 20 mM ADU melt. The total exploitation of uranium in the final product ranges from 95 to 100%. The importance of the new process is related also to the possibility for a direct processing of poor melts of U (VI). (auth)

23868 AMERICAN COMPANY CUTS COSTS BY MACHINING URANIUM CARBIDE DRY. Ind. Diamond Rev., 27: 353-4(Aug. 1967).

Defects in enriched UC fuel slugs are cut out with copper bonded diamond wheels and the slugs are circumference ground on diamond centerless-grinding wheels without use of coolants. (P.G.C.)

23869 EDM TECHNIQUES FOR MACHINABLE CARBIDES. Weber, John S. Mach. Tool Blue Book, 62: No. 6, 124-7(June 1967).

The principal factors affecting the results of electrical-discharge machining of machinable carbides are discussed. End wear ratios of electrode materials, such as Elomet 3, brass, compacted Cu, graphite, and Cu-W, are compared. Graphite-based electrodes are most suitable. Basic techniques are outlined regarding design and manufacture of electrodes; condition of EDM machine and lineup of electrodes; tolerances and clearances and clearances of sections; and surface finish required. Surface embrittlement caused by EDM is eliminated in machinable carbides by heat treating. (Rev. Metal Lit.)

23870 VAPOR COATED SURFACES FOR BRAZING CERAMICS. Brush, E. F. Jr. (Union Carbide Corp., Parma, Ohio); Adams, C. M. Jr. Weld. J. (N. Y.), 47: 106s-114s(Mar. 1968).

The enhancement of wetting, spreading, and capillary flow in brazing was studied and developed through electron beam evaporation of a metallic vapor coating to the surface of the difficult-to-wet material. This technique was applied with numerous metallic vapor coatings on alumina substrates to determine the degree of wetting promotion using various coatings, braze materials, and coating conditions. Ti and Zr vapor coatings were most effective in wetting; Cr and Ca coatings also promoted wetting, but to lesser degrees. Ti vapor coatings on coarse grain alumina exhibited a threshold coating thickness between 3 and 4μ above which the coating had a smooth surface that promoted wetting and complete capillary flow at temperatures as low as 1300 and 1400°F, respectively. Thinner Ti coatings showed surface roughness and behaved comparably only at temperatures 200°F higher. Zr coatings promoted wetting above 1575°F with complete capillary flow above 1650°F. Cr and Ca vapor coatings promoted wetting above 1600°F but complete flow over the surface did not occur by 1800°F at which temperature some coating vaporization occurred. Vapor coatings of Si, Ge, Ni, Mo, Nb, B, Ag, and Mn promoted wetting only slightly, and at high brazing temperatures. Oxidized and oxide vapor coatings behaved essentially as the uncoated alumina substrates. The mechanism of wetting promotion, as studied with Ti, Zr, and Cr vapor coatings, is through liquid braze alloy penetrating, reacting, breaking up, displacing and tunneling under the vapor coating. Using alumina substrates tunneling ocurred at the coating/substrate interface, and after complete braze, alloy-flow atop the vapor coating occurred. Wetting, spreading, and tunneling were studied as functions of coating type, thickness, braze material, and brazing temperature. (auth)

23871 PREPARATION OF UO_2-Mo AND UO_2-W CERMETS FUEL BY METAL VAPOR DEPOSITION IN FLUIDIZED BED AND HOT PRESSING. Amato, Ignazio; Ardizzone, Laura (FIAT, Turin). Rev. Int. Hautes Temp. Refract., 4: 297-302(Oct.-Dec. 1967). (In French).

Cermets of UO_2-Mo and UO_2-W were prepared by metal vapor deposition in a fluidized bed and hot pressing. UO_2 spheroids were coated with Mo by hydrogen reduction of molybdenum pentachloride and by thermal decomposition of molybdenum hexacarbonyl. The best results were obtained with the first process because it was possible to operate at a higher deposition rate and to obtain coatings with better adherence. Spheroids of UO_2 were coated with W by hydrogen reduction of tungsten hexachloride and tungsten hexafluoride. The best results were obtained by hydrogen reduction of tungsten hexafluoride because it was possible to operate at very high deposition rates and obtain good coatings. All the spheroids coated with the described processes were hot pressed at 1600°C and 500 kg/cm². Cermets of high densities (90 to 95% of theoretical values) were obtained. (auth)

23872 REDUCTION OF OXIDES AND OXIDE SYSTEMS BY HYDROGEN. Pospisil, Milan (Inst. of Technology and Nuclear Physics, Prague). Chem. Listy, 61: 1393-1428(Oct. 1967). (In Czech).

The literature (169 references, largely English and German) is reviewed on reduction of metal oxides and mixed metal oxides in gas-solid systems. The significance of the reaction in metallurgy of both metals and alloys is shown, and the basic thermodynamic relations and their application to reduction processes are discussed. Important methods for direct study of the reduction reaction, for studying physicochemical properties of solids, and for clarifying the reduction process are reviewed. The reduction of oxides as a final step in obtaining metal catalysts is emphasized. The electron mechanism in the reduction of semiconducting oxides and the kinetics and the importance of individual steps in the overall reduction rate are considered. The kinetic equations that describe reduction processes are given, and data obtained from studies on reduction of metallic and mixed metal oxides and on the effect of variables on the course and the kinetics of the reduction process are presented. (TTT)

23873 HIGH DENSITY URANIA FUEL ELEMENTS. St. Pierre, Philippe D. S. (to General Electric Co.). U. S. Patent 3,342,562. Sept. 19, 1967. Filed Oct. 28, 1960.

Fuel elements of UO_2 are prepared by compacting ammonium diuranate, heating at a controlled rate to 500°C to effect decomposition of the diuranate, and sintering at 1500 to 1700°C under dry hydrogen. Compacts prepared by this method have a density of at least 95% of theoretical and an O/U ratio of 2.00. (P.G.C.)

23874 GRAPHITE BRICK STRUCTURES. Triggs, Geoffrey William (to United Kingdom Atomic Energy Authority). U. S. Patent 3,342,693. Sept. 19, 1967. Priority date Dec. 4, 1964, Great Britain.

Dimensional changes, including bowing, in graphite bricks undergoing neutron irradiation in a reactor are modulated by a design in which the bricks are engaged with their neighbors by cooperating projections and recesses provided on adjacent faces. The projections have curved working faces and a central minor portion defining a pair of parallel straight edges so that vertically abutting bricks can pivot on either edge. (P.G.C.)

23875 GRAPHITE BODY. (to Union Carbide Corp.). British Patent 1,107,590. Mar. 27, 1968. Priority date Aug. 14, 1964, United States.

A method for preparing isotropic graphite comprises use of residues from vacuum distilled Mid-Continent crude oil having a melting point of about 15°C, heating above the melting point and blowing through the melt an O-containing gas until the melting point is raised to at least 150°C. The treated residue is coked at 450 to 650°C, calcined at 900 to 1500°C, ground to a flour and mixed with a carbonizable aromatic binder. The material is then shaped by molding or extrusion and heated in the range of 750 to 1000°C to carbonize the binder and expel volatiles. The body is finally graphitized at 2000 to 3000°C in an inert atmosphere. (P.G.C.)

23876 GRAPHITE BODY. (to Union Carbide Corp.). British Patent 1,107,836. Mar. 27, 1968. Priority date Aug. 14, 1964, United States.

Techniques for producing graphite bodies which have a substantially isotropic coefficient of thermal expansion and also a coefficient of thermal expansion which closely matches that of refractory metals or carbides are described. Particular applications for these bodies, when coated with refractory metals or carbides to protect them from oxidation and surface erosion, are found in aerospace and nuclear environments. (P.G.C.)

23877 SINTERED URANIUM DIOXIDE–IRIDIUM COMPOSITION AND METHOD OF PREPARATION. Elyard, Charles Anthony; Potter, Terence Jefferson (to United Kingdom Atomic Energy Authority). U. S. Patent 3,342,744. Sept. 19, 1967. Priority date Apr. 23, 1965, Great Britain.

Addition of 0.1 to 4 wt % Ir to UO_2 ceramic fuel inhibited columnar grain growth when specimens were heated in an arc image furnace at 1800° for 25 hrs. Equi-axed grain growth from 10 μ to 25 μ occurred in Ir-containing specimens without columnar growth while UO_2 specimens prepared and heated in the same manner showed a columnar grain growth of about 250 μ in length and an equi-axed diameter of 40 μ. (P.G.C.)

23878 METHOD OF FORMING A REFRACTORY METAL BODY CONTAINING DISPERSED REFRACTORY METAL CARBIDES. Delgrosso, Eugene J.; Friedrich, Leonard A. (to United Aircraft Corp.). U. S. Patent 3,343,952. Sept. 26, 1967. Filed Apr. 21, 1966.

A process is described for forming dispersion strengthened alloy articles of refractory metals such as niobium, tantalum, molybdenum, tungsten, titanium, and alloys thereof in which fine powders of the desired metal or metals are provided with a thin carbide shell in a fluidized bed and are subsequently warm or hot worked to fracture the shell and uniformly disperse the carbide throughout the article. (P.G.C.)

23879 SINTERED URANIUM DIOXIDE CONTAINING YTTRIUM OXIDE. Elyard, Charles Anthony; Potter, Terence Jefferson (to United Kingdom Atomic Energy Authority). U. S. Patent 3,344,081. Sept. 26, 1967. Priority date Jan. 22, 1965, Great Britain.

Addition of 0.5 to 5 wt % of Y_2O_3 to polycrystalline UO_2 reactor fuel inhibited columnar grain growth up to 2000°C and reduced rate of diffusion of Xe and Kr through the UO_2 ceramic. (P.G.C.)

23880 REFRACTORY OXIDES DOPED WITH SILICON CARBIDE AND SILICON NITRIDE. Livey, David Thomas; O'Neill, John Sidney (to United Kingdom Atomic Energy Authority). U. S. Patent 3,344,080. Sept. 26, 1967. Priority date Sept. 16, 1964, Great Britain.

Grain growth in refractory oxides such as beryllia, alumina, magnesia, thoria, zirconia, or uranium dioxide is inhibited during sintering by addition of <10 wt % of SiC or Si_3N_4 in submicron size. Grain size of the final body may be restricted to <5 μ thereby increasing strength of the body at high densities. (P.G.C.)

23881 HYDROSTATIC EXTRUSION OF SHEATHED CERAMIC NUCLEAR FUEL MATERIAL. Green, Derek (to United Kingdom Atomic Energy Authority). U. S. Patent 3,344,507. Oct. 3, 1967. Priority date Dec. 19, 1962, Great Britain.

A method for producing sheathed fuel elements by extrusion employs a die, a container for the pressurized fluid and for the fuel element to be extruded, and means for pressurizing the fluid to drive the element through the die. Prior to extrusion the fuel element is coated with a tenacious deformable coating to prevent direct contact with the die and provide a seal during extrusion to eliminate escape of pressurized fluid past the die. (P.G.C.)

23882 PREPARATION OF BERYLLIUM OXIDE OF FINE PARTICLE SIZE THRU CRYSTALLIZATION AND CALCINATION. Steele, Bernard Robert; Rigby, Frank (to United Kingdom Atomic Energy Authority). U. S. Patent 3,345,133. Oct. 3, 1967. Priority date Mar. 19, 1964, Great Britain.

Powders of BeO having a surface area in the range of 10 to 20 m^2/g are produced by passing a hot saturated solution of $BeSO_4$ into a chilled and continuously cooled aqueous solution of at least one organic alcohol, separating the beryllium tetrasulfate so produced, heating the beryllium sulfate dihydrate under vacuum for 12 hr, and calcining the crystals in air at 900 to 1100°C. The sintered powders produce bodies having a bulk density of 95% of theoretical. (P.G.C.)

23883 PROCESS FOR THE PREPARATION OF A URANIUM, PLUTONIUM, OR THORIUM CARBIDE. Beucherie, Pierre; Payrissat, Maurice; Wurm, Joseph Gerard (to European Atomic Energy Community). British Patent 1,107,748. Mar. 27, 1968. Priority date Sept. 1, 1964, Belguim.

UC, PuC, or ThC can be prepared by reacting their halides with C and a reducing metal or with the carbide of the reducing metal. The reaction is carried out in vacuo at a temperature of at least 1200°C. The reaction mixture consists of stoichiometric quantities of the U, Pu, or Th halide and graphite and an amount of a reducing metal, such as Al, that exceeds by 30 to 40 wt % the stoichiometric quantities of the halide and the graphite. (B.L.M.)

23884 PROCESS FOR PREPARING NUCLEAR FUEL ELEMENTS OF DISPERSED-IN-GRAPHITE TYPE. Ishihara, Takehiko; Honda, Toshio; Ohwada, Ken (to Japan Atomic Energy Research Inst.). U. S. Patent 3,342,910. Sept. 19, 1967. Priority date Nov. 5, 1963, Japan.

A process is given for preparing improved uniform dispersions of U in graphite, which are impermeable to fission products and resistant to oxidation and strong reagents. The process comprises mixing furfural, phenol, uranyl nitrate, and a small amount of HCl as catalyst; polymerizing the mixture at 80 to 200°C to form a solid resin body; carbonizing the resin body at 1200°C in a protective atmosphere; and cooling slowly to room temperature. The variables in the process are discussed. Comparative data on the oxidation of the dispersions and ordinary graphites are given. (D.L.C.)

23885 MODERATOR-FUEL ELEMENT. Bourrasse, Andre; Carteret, Yvette; Elston, Jean; Lucas, Renee (to Commissariat a l'Energie Atomique). U. S. Patent 3,342,692. Sept. 19, 1967. Priority date Apr. 26, 1965, France.

A moderator-fuel element and a fabrication method were developed for spacecraft reactors. The element comprises a dispersion of Mo-coated fuel particles (UO_2, say) in yttrium hydride moderator. (Yttrium hydride is stable at >900 to 1000°C). The element is clad with a can of Mo or a refractory alloy which is lined internally with a layer for inhibiting diffusion of H. The layer may be an aluminum silicate-zirconium silicate enamel, covered by a thin Mo film. The fabrication method comprises grinding Y, mixing

the ground Y with coated fuel particles, sintering the mixture, placing the sintered product in the can, and hydriding the product. (D.L.C.)

Properties Evaluations

Refer also to abstracts 23200 and 23862.

23886 MICROSCOPIC ASPECTS OF FRACTURE IN WC–Co ALLOYS. Luyckx, Silvana Bartolucci (Univ. of Witwatersrand, Johannesburg). Acta Met., 16: 535-44(Apr. 1968).

Fractographic studies by optical microscopy have been carried out on WC–Co alloys fractured in bending tests. Plastic deformation has been found to precede, accompany, and follow fracture. The characteristics of plastic deformation have been observed to depend on the composition of the specimens, which has been explained in terms of the microstructure of the material. (auth)

23887 THE CaO–SrO–Al_2O_3–ZrO_2 SYSTEM IN THE TECHNOLOGY OF REFRACTORY MATERIALS. Tarnopol'skaya, R. A.; Gul'ko, N. V. (Inst. of Refractory Materials, Kiev). Ogneupory, No. 12, 38-41(Dec. 1967). (In Russian).

Physico-chemical properties of CaO-SrO-ZrO_2-Al_2O_3 system with the melting points of the oxides at 2570, 2430, 2700, and 2043°C, respectively, were studied in order to determine their place in the ceramic and refractory technology. The results obtained show that the combination of the above oxides cannot be used as a satisfactory high-refractory material. (R.V.J.)

23888 OXIDATION AND DEFORMATION STUDIES OF URANIUM NITRIDE BY ELECTRON MICROSCOPY. Sole, M. J.; Van Der Walt, C. M. (Atomic Energy Board, Pretoria). Acta Met., 16: 501-10(Apr. 1968).

Transmission electron microscopy and electron diffraction techniques have been used to study the oxidation and deformation of UN single crystals. The initial oxidation product is epitaxial U_2N_{3+x} which may contain ordered oxygen atoms. As oxidation proceeds a double protecting film of UO_2 and U_2N_{3+x} is formed and orientation relationships existing between the phases are $\{001\}_{UO_2} \parallel \{001\}_{U_2N_{3+x}} \parallel \{001\}_{UN}$ and $\langle 100\rangle_{UO_2} \parallel \langle 100\rangle_{U_2N_{3+x}} \parallel \langle 100\rangle_{UN}$. Slip traces are commonly observed and show that the primary slip system of UN is $\{101\}\langle\bar{1}01\rangle$. A secondary slip system $\{112\}\langle\bar{1}10\rangle$ also exists. (auth)

23889 ENTHALPY AND HEAT CAPACITY OF ZIRCONIUM CARBIDE IN THE HOMOGENEITY DOMAIN OVER THE TEMPERATURE RANGE 1300 TO 2500°K. Turchanin, A. G.; Fesenko, V. V. (Inst. of Problems in Studies of Materials, Kiev). Porosh. Met., Akad. Nauk Ukr. SSR, No. 1, 88-90(Jan. 1968). (In Russian).

The values of enthalpy of three compositions of zirconium carbide were determined in the homogeneity domain at 1300 to 2500°K by means of a vacuum calorimeter device. The equations of enthalpy and heat capacity dependences of the investigated carbides, on the temperature, were calculated from the experimental data. (tr-auth)

23890 SPALLING RESISTANCE OF CERAMIC COATINGS ON METALS. Demchenko, N. S.; Podrolkina, E. I.; Demchenko, L. G. Glass Ceram. (USSR) (Engl. Transl.), 24: 83(1967).

The coatings tested contained (parts by wt.): frit of unstated composition, 100; clay, 40; water, 50; Cr_2O_3, ZrO_2 or Al_2O_3, 0, 1, 10 or 30. The coatings were fired-on at 1000 to 1150°. For the thermal-shock test, specimens were held at 950 to 1000° for 10 min, cooled to 500 to 550° by holding them in the air for 15 sec and then plunged into water at 20° for 5 min. In another test the tested specimens were exposed to a blast of air at 30° and a pressure of 4 lb/in^2. The test-pieces were examined after 10, 30, 50, and 100 cycles. The addition of Cr_2O_3 improved thermal shock resistance. (Brit. Ceram. Abstr.)

23891 BERYLLIA CERAMICS. Hessinger, P. S.; Cliffe-Jones, R. Electron. Equip. News, 56-60(Jan. 1968).

A description is given of the physical properties of beryllium oxide, comparing them with those of other materials, and also some of the growing number of applications. (auth)

23892 TUNDISH NOZZLES FOR THE CONTINUOUS CASTING OF STEEL. Koike, S. Tetsu To Hagane, 52: No. 11, 56(1966). (In Japanese).

The following types of nozzles were tested and their properties are given: fireclay, plumbago, high-alumina, zirconia, zircon, and zircon/chromic oxide. A relationship was found between the casting time, the temperature, the erosion and ZrO_2 content of the zircon products. (Brit. Ceram. Abstr.)

23893 MEASUREMENT OF OXYGEN PRESSURE CHANGE IN OXIDE POWDERS BY OXYGEN CONCENTRATION CELLS. Kashida, Koichi; Goto, Kazuhiro; Someno, Mayumi (Tokyo Inst. of Tech.). Trans. Met. Soc. AIME, 242: 82-7(Jan. 1968).

An experimental method which gives new information on the micromechanism of the reduction of oxides by gases at elevated temperature was developed. The intermediate phases of the W–O system, formed during the reduction were described. A Galvanic cell with the solid electrolyte, ZrO_2–CaO, was imbedded in powders of WO_3, CuO, or Fe_2O_3 with two measuring electrodes and with a reference electrode. The change of the intraparticle gas composition was measured at 600 to 1000°C during the reduction by the gas mixture of hydrogen and argon. The intraparticle gas composition changes stepwise with time. The electromotive force of such temporary interruption corresponds to the equilibrium electromotive force of two solid phases formed during the reduction. The intermediate phases of W–O system, which are formed in a large quantity during the reduction by hydrogen, are $WO_{2.90}$, $WO_{2.72}$ and WO_2. The micromechanism of the reduction of oxides by gases is discussed. (auth)

23894 STRUCTURE AND PROPERTIES OF CERMETS. Petzow, Guenter; Claussen, Nils; Exner, Hans Eckart (Max-Planck-Institut fuer Metallforschung, Stuttgart). Z. Metallk., 59: 170-9(Mar. 1968). (In German).

Cermets can be treated as a special group of composite materials. An exact definition and classification, however, is rather difficult due to the wide range of developments. Their structure is ruled by geometry and distribution of the different phases as well as by their constitution with broad miscibility gaps. The properties influenced by these factors are discussed in terms of theoretical and empirical relations across the entire concentration range. Bonding between ceramic and metallic phase seriously affects the property dependence on concentration. Relation for strength, Young's modulus, thermal expansion as well as electrical and thermal conductivity are discussed in detail. (tr-auth)

23895 INVESTIGATION OF THE BONDING MECHANISM BETWEEN METALS AND CERAMICS. Helgesson, Claes I. Scandinavian University Books. Goteborg, Chalmers University of Technology, 1966. 121p. Sw. Crs 30.00.

Thesis.

The bonding mechanisms in ceramic-to-metal seals, especially to ceramics with very little or no glass phase were investigated. The investigation was concentrated on pure alumina materials with a varying amount of impurities (0.0 to 6 wt %). Some tests were also performed with beryllia ceramics. The microstructure and formation of secondary phases in the ceramic–metal interface were investigated using modern analyzing techniques such as electron microprobes and x-ray diffraction techniques. (Sweden)

Structure and Phase Studies

Refer also to abstract 24408.

23896 (CONF-670502–, pp 194-9) CRYSTAL CHEMISTRY AND PHASE EQUILIBRIA IN THE SYSTEM Eu–Ti–O. McCarthy, Gregory J.; White, William B.; Roy, Rustum (Pennsylvania State Univ., University Park. Materials Research Lab.).

The crystal chemistry and phase equilibria of the ternary system Eu–Ti–O were investigated in open and closed systems in the temperature range from 900 to 1500°C. The known bounding binary systems include the compounds Eu_2O_3, Eu_3O_4, and EuO on the europium–oxygen side and TiO_2, the Ti_nO_{2n-1} homologous series, Ti_3O_5, Ti_2O_3, TiO, Ti_2O, and Ti_3O on the titanium–oxygen side. The join Eu_2O_3–TiO_2 contains in addition to the known pyrochlore structure $Eu_2Ti_2O_7$, the monoclinic compound Eu_2TiO_5. On the joins Eu_2O_3–Ti_2O_3 and EuO–TiO_2, the perovskite $EuTiO_3$ with divalent europium and tetravalent titanium is shown to have an extremely wide range of stability. The join EuO–TiO is apparently not binary and bulk compositions along this join dissociate into oxygen-rich and oxygen-poor phases. Particular attention was placed on the highly reduced compounds in the metal-rich section of the diagram because of the possibility of finding compounds with unusual electrical properties. (auth)

23897 (CONF-670502–, pp 200–12) SOME TENSIMETRIC STUDIES OF THE SYSTEM $Ce_yTb_{1-y}O_x$. Kordis, J. (Du Pont de Nemours (E. I.) and Co., Wilmington, Del.); Eyring, LeRoy (Arizona State Univ., Tempe. Dept. of Chemistry).

The isobaric technique applied to a study of P, T, x relationships proved to be a powerful method of revealing the intricacies of the complex phase relationships in pure PrO_x and TbO_x systems. The sorting out of this pattern of ordered intermediate phases of narrow ranges of composition (homologous series), phases of wide composition range (nonstoichiometric phases), "pseudo phase" formation, which accompanies phase reactions with symmetry reduction, and chemical hysteresis, which is generally observed in two phase regions, will advance the under-

standing of the detailed nature of the solid state and the reactions that solids undergo. A study of the system $Ce_yTb_{1-y}O_x$ was accomplished to reveal the effect of cation substitution between analogous systems on their thermodynamic behavior as revealed by tensimetric measurements. Mixed oxides were prepared at intervals of 10 at. % cerium and isobaric studies made at oxygen pressures between 10^{-3} and one atmosphere. For one particular mixed oxide, $Ce_{0.2}Tb_{0.8}O_x$, isothermal studies (10^{-5} to one atmosphere) were carried out as well. To a first approximation there is no valency stabilization of the TbO_x by the presence of CeO_x, however, a careful examination of the isobars reveals the existence of a widely nonstoichiometic phase in the mixed system, which is observed in the pure PrO_x system but not in the pure TbO_x studies reported earlier. In addition, apparent hysteresis and pseudo phase formation appear, which are characteristic of the behavior of the pure TbO_x and PrO_x systems. There is a general "smearing out" of the isobars indicating less definite intermediate phases of narrow composition range and two-phase regions although both are indicated in some instances. (auth)

23898 (CONF-670502–, pp 213-22) EQUILIBRIA, POINT DEFECT NATURE AND KINETICS IN THE SYSTEMS OF RARE EARTHS AND DI- OR TETRAVALENT OXIDES. Roy, Rustum; Diness, A. M.; Barry, T. L. (Pennsylvania State Univ., University Park. Materials Research Lab.).

Detailed investigations by quenching, DTA, high temperature, x radiation, and high-pressure water catalysis were made on the systems $CaO-Yb_2O_3$, $CaO-Gd_2O_3$, $CaO-La_2O_3$, $ThO_2-Yb_2O_3$, $ThO_2-Gd_2O_3$, and $ThO_2-La_2O_3$. New or revised equilibrium diagrams are presented for all the systems. One feature is the large number of new compounds previously unreported. In the $CaO-Yb_2O_3$ system for example, there are four compounds, all decomposing below 1800°C. In the $ThO_2-La_2O_3$ system, there are two previously unreported compounds. The extent of crystalline solubility of the rare earths in CaO and ThO_2 does not follow the expected dependence on ionic radii or ionic field strength differences. An anion vacancy model is confirmed for ThO_2 (matrix)$-Ln_2O_3$(solute) solutions near 1900°C; a cation vacancy model for $CaO-Ln_2O_3$; and an interstitial anion model for $Gd_2O_3-ThO_2$, an extensive series of crystalline solutions with the C-type structure. The kinetics of the solid-state decomposition of $CaYb_2O_4 \rightarrow CaO + Yb_2O_3$ follows zero order kinetics. Interpretation of these and similar kinetic data is discussed. (auth)

23899 ELECTRON DIFFRACTION STUDY OF THE OXIDE FORMED ON CEMENTED TUNGSTEN CARBIDE–TITANIUM CARBIDE CUTTING TOOLS. Stanislao, J. (Univ. of Rhode Island, Kingston); Richman, M. H.; James, C. F. Jr. J. Eng. Ind., 90: 92-6(Feb. 1968).

The oxide protecting the surface of cemented carbide cutting tools containing both tungsten and titanium carbides is identified by electron diffraction as Ti_2O_3, which is formed during the cutting operations. This is a protective and adherent oxide which is formed as an intermediate layer between the TiC-TiO solid solution (the titanium carbide particle) and an outer layer of TiO_2. The outer layer of TiO_2 is spalled off by the abrasive action of the chip and only the Ti_2O_3 layer protects against welding of the chip fragments to the tool. (auth)

23900 PHASE EQUILIBRIA IN THE SYSTEMS TANTALUM–TITANIUM–BORON AND TANTALUM–MOLYBDENUM–BORON. Sobolev, A. S.; Kuz'ma, Yu. B.; Soboleva, T. E.; Fedorov, T. F. (Baikov Inst. of Metallurgy, USSR. Lvov State Univ.). Porosh. Met., Akad. Nauk Ukr. SSR, No. 1, 62-7(Jan. 1968). (In Russian).

The systems $Ta-Ti-B$ and $Ta-Mo-B$ were investigated by means of x-ray and microstructural analyses. Phase equilibria in these systems are shown. The compound TaB dissolves 10 at. % of Ti, the compound TiB–10 at. % of Ta. In the system $Ta-Mo-B$ the compounds Ta_3B_2 and TaB dissolve 40 at. % of Mo, the compound Mo_2B–10 at. % of Ta. The change of lattice parameters of binary borides corresponds to atomic radii of component size. (tr-auth)

23901 CRYSTAL-CHEMICAL INTERPRETATION OF SOME INTERMEDIATE PHASES IN THE $CaO-HfO_2(ZrO_2)$ AND $RE_2O_3-TiO_2(ZrO_2)$ SYSTEMS. Pyatvenko, Yu. A. Dokl. Akad. Nauk SSR, 173: 634-7(1967). (In Russian).

It was found that phases containing 20 mole % of CaO in the $Ca-ZrO_2$ system contain fluorite-like structures, with coordination numbers of 8 and 7 for the Ca and Zr, respectively. Crystal-chemical evaluation of experimental data revealed that within the stabilized area, the compound $CaO \cdot 4ZrO_2$ is the most stable phase; it corresponds to an ordered distribution of the Ca and Zr polyhedra within the structure, representing the stoichiometric compound $CaZr_4O_9$. Similar observations were made in the $CaO-HfO_2$ system, where at about 1450°C, in the molar concentration range between 8 and 20 mole % CaO, only the phase $CaHf_4O_9$ and HfO_2 were found to exist. Until recently, it was assumed that only the pyrochlore-like compound, $RE_2Ti_2O_7$ is the intermediate phase in the $RE_2O_3-TiO_2$ system, but the isostructural, strictly stoichiometric compounds Gd_2TiO_5, Dy_2TiO_5 and Y_2TiO_5 were also observed. X-ray diffraction studies showed that these monoclinic structures may be derived from CaF_2. Structures supplementary to the pyrochlore are also possible; they may be derived from the fluorite with heptagonal Pauling polyhedra. Examples are $RE_2Zr_2O_7$, whereby RE designates heavy lanthanides with ionic radii close to that of Zr^{4+}, e.g., $Lu_2{}^{[7]}Zr_2{}^{[7]}O_7$. (TTT)

23902 CONSTITUTION DIAGRAM FOR THE ZIRCONIUM–ZrN–ZrC SYSTEM. Danisina, I. N.; Vil'k, Yu. N.; Avarbe, R. G.; Omel'chenko, Yu. A.; Ryzhkova, T. P. Zh. Prikl. Khim., 41: 492-500(Mar. 1968). (In Russian).

A constitution diagram was constructed for the $Zr-ZrC-ZrN$ system at 1600°C. Experimental studies were made of the melting points of alloys of $ZrC_{0.923}-ZrN_{0.18}$ cross section. The results were in good agreement with isobar-isothermal potentials calculated for constitution diagrams of $ZrC-ZrN$ and $ZrC_{0.923}-ZrN_{0.818}$. (R.V.J.)

23903 STRUCTURAL STUDY IN THE SYSTEM $HfO_2-Y_2O_3$. Caillet, Marcel; Deportes, Charles; Robert, Guy; Vitter, Gerard (Faculte des Sciences, Grenoble, France). Rev. Int. Hautes Temp. Refract., 4: 269-71(Oct.-Dec. 1967). (In French).

The study which was carried out only in the interval of 0 to 50 moles HfO_2 for 100 Y_2O_3 was done by diffractometry at ordinary temperature and also by thermal expansion on samples sintered at 1800°C. The cubic solid solution of fluorite type alone appears between 9 and 40 moles per 100 Y_2O_3. The observation of an anomaly on the curve representing the variation of the crystalline parameter of this phase as a function of the composition, and the observation of a maximum of the coefficient of expansion for the composition of 33.3 moles per 100 Y_2O_3, as well as the results of the study of electrical conductivity, indicate that there exists a compound $Y_2Hf_2O_7$; nevertheless no extra lines have been observed on the diffraction patterns. (tr-auth)

Radiation Effects

23904 (CONF-660524–, pp 463-73) IRRADIATION OF $(Th,Pu)O_2$. Freshley, M. D.; Mattys, H. M. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab. European Atomic Energy Community, Karlsruhe (West Germany). Transuranium Inst.).

The irradiation behavior of $(Th, Pu)O_2$ fuel has been investigated on a limited scale. The sinterability, melting point, and lattice parameters were investigated in preparation for in-reactor evaluation. Zircaloy-clad capsules containing $(Th,Pu)O_2$ pellets were irradiated. The pellets were prepared by wet ball milling –325 mesh ThO_2 and plutonium oxalate to obtain an intimate mixture of the fine powders. Calcining the powder mixtures in air at 900°C converted the plutonium oxalate to PuO_2. A green density of 60% of theoretical was achieved by double-pressing without binder. A final density of approximately 95% of theoretical and solid solution was achieved by sintering in hydrogen at 1600°C for 6 hr. The Zircaloy-clad capsules were shrink-fitted into 2.86-cm-OD aluminum sleeves to permit higher heat generation rates. Capsules of five different compositions were irradiated under a variety of conditions to maximum burnups of approximately 3×10^{20} fissions/cm^3 and at maximum rod power generations of over 1000 watts/cm with central fuel temperatures above melting. All capsules survived the irradiation, although the inner Zircaloy cladding failed on two of the high-power high-burnup specimens. Structures developed during the irradiation of $(Th,Pu)O_2$ fuel were similar to those formed during the irradiation of UO_2, UO_2-PuO_2, and ZrO_2-PuO_2 fuels. (auth)

23905 GAMMA RADIATION EFFECT ON THE MAGNETIC CRYSTALLOGRAPHIC ANISOTROPY CONSTANT IN NICKEL AND NICKEL–COPPER FERRITE SINGLE CRYSTALS. Sirota, N. N.; Ges, A. P. (Inst. of Solid-State and Semiconductor Physics, Minsk). Dokl. Akad. Nauk BSSR, 11: 774-6(1967). (In Russian).

An experimental investigation was made of the effect of various dosages of gamma-radiation on the first anisotropy constant of $NiFe_2O_4$ and nickel-copper ferrite single crystals containing 25 and 50 mol. % $CuFe_2O_4$. The temperature dependence of the anisotropy constant of the $NiFe_2O_4$ before irradiation shows a drop at 100 to about 200°K, reaches a minimum of -6×10^{-4} erg/cm^3 at about 200°K, and rises to about -2×10^{-4} erg/cm^3 at 500°K. The gamma-irradiation, without changing the general character of the dependence, decreases the magnitude of the constant with increased dosage of radiation, except at temperatures above 350°K, where the 2.2×10^9 R dose brings about a slight increase of the constant. In the nickel-copper ferrite containing 25 mol. %

$CuFe_2O_4$, an increase of the anisotropy constant was brought about by an increase of the radiation dose at all temperatures at which the constant had a negative value. The inversion temperature remained constant at all radiation doses. The temperature of the maxima of the anisotropy constant values apparently was independent of the radiation dose. At about 150°K the anisotropy has a considerable temperature dependence which, in the case of $Ni_{0.75}Cu_{0.25}Fe_2O_4$, is virtually independent of the radiation dose. (ATD)

23906 STRUCTURAL CHANGES IN SOME CERAMIC MATERIALS DURING NEUTRON IRRADIATION. Kostyukov, N. S.; Antonova, N. P.; Naidenova, G. A.; Moroz, I. Kh.; Medvedovskaya, E. I.; Rodina, N. P.; Zin'ko, E. I. Izv. Sib. Otd. Akad. Nauk SSSR, Ser. Khim. Nauk, No. 9, 43-6(July 1967). (In Russian).

The structural changes of high-alumina and mullite–corundum ceramic materials during irradiation with thermal neutrons were investigated by petrographic, infrared spectroscopic, and x-ray methods. It was established that during irradiation with doses up to 1×10^{20} neutrons/cm^2 substantial changes in the crystal phases do not occur. Changes in the glass phase were assumed. (tr-auth)

23907 FISSION GAS IN UO_2. Soulhier, R.; Hairion, J. P. (CEA, Grenoble, France). 11p. (In French). (CONF-660223-1). DTIE.

From Conference on New Ceramics, Sevres, France.

The creation of fission-produced foreign atoms in UO_2 is described. The faults created by this process and by the associated thermal phenomena are outlined. The experimental results obtained relative to the behavior of these atoms during long duration irradiation are presented. The case of rare gases whose migration causes serious technological problems for reactor constructors are considered especially. A study of the mechanisms accompanying the fission of a U atom in the UO_2 lattice reveals that the associated phenomena are still poorly known. It is only at low temperature that the phenomena causing the liberation of gases can be defined in a relatively precise fashion. The mechanisms of the isothermal release at temperatures above 800°C are poorly known and the intervention of a temperature gradient complicates the analysis of the release to the point that only empirical information can be obtained. (J.S.R.)

Plastics and Other Materials

Refer also to abstracts 23711 and 23712.

23908 APPLICATION OF ADHESIVES IN NUCLEAR ENGINEERING. Aitken, A. D. (Atomic Energy Research Establishment, Harwell, Eng.). Sheet Metal Ind., 42: 736-8; 742(Oct. 1965).

Organic adhesives were all affected by nuclear radiation. Although initially some bonds were strengthened they were degraded eventually if the radiation level was high enough. Radiation effects on degradation, tensile properties, and fatigue life of polystyrene, epoxy, polyvinyl chloride, polytetrafluoroethylene, polyethylene, cellulosic vinyl, nylon, acrylic, and polyester adhesives are discussed. The use of epoxy resins for bonding copper to copper was also investigated. (J.G.B.)

23909 ORGANIC ANTI-CORROSIVE COATINGS IN THE NUCLEAR TECHNIQUE. Bulczynska, Ludwika; Kwiatkowski, Andrzej; Bieguszewski, Zygmunt; Winnicki, Ryszard (Instytut Farb i Lakierow, Gliwicach, Poland. Instytut Badan Jadrowych, Warsaw). Przem. Chem., 46: 669-72(Nov. 1967). (In Polish).

Laboratory studies were carried out on the resistance of various pigment coatings on epoxy resins in aggressive media and the resistance of these coatings to ionizing radiation, emitted by the burnt fuel elements of the reactor EWA. It was found that the best properties were exhibited by coatings of solventless epoxy-polyamide dye. This dye was chosen for protection of steel and concrete surfaces against corrosion and ionizing radiation in reactor centers. (tr-auth)

PHYSICS (GENERAL)

Astrophysics and Cosmology

Refer also to abstracts 23376, 23377, 24067, 24070, 24141, 24146, and 24171.

23910 (ORO-2529-17) RADIOACTIVE FALLOUT IN ASTRONOMICAL SETTINGS: ^{244}Pu IN THE EARLY ENVIRONMENT OF THE SOLAR SYSTEM. Kuroda, P. K. (Arkansas Univ., Fayetteville. Dept. of Chemistry). Mar. 19, 1968. Contract AT(40-1)-2429. 28p. (CONF-680308-3). Dep. CFSTI.

From 155th National Meeting of the American Chemical Society, San Francisco, Calif.

An attempt is made to find an analogy between the processes of formation and transport of "hot" single particles from nuclear weapons and formation of the solar system from the debris of supernova explosions. The detection of xenon isotopes in meteorites as a residue of ^{129}I and ^{244}Pu is considered. (W.D.M.)

23911 (UCRL-50384) ATTEMPT TO DETECT GAMMA RADIATION FROM THE CONSTELLATION CYGNUS. Gilbert, F. Charles; Seward, Frederick D.; Stoering, J. Peter (California Univ., Livermore. Lawrence Radiation Lab.). Feb. 27, 1968. Contract W-7405-eng-48. 11p. Dep. CFSTI.

In an attempt to observe x rays and gamma rays between 100 keV and about 3 MeV from the Cygnus X-1 source, a balloon-borne experiment was conducted on April 22, 1967. The 511-keV positron-electron annihilation line was of particular interest. The detector assembly is described and operating characteristics are given. The upper limit found for Cyg X-1 was 0.07 photons/cm^2-sec. (W.D.M.)

23912 (NASA-TT-F-521) MAGNETOBREMS (SYNCHROTRON) EMISSION AND REABSORPTION. Ginzburg, V. L.; Sazonov, V. N.; Syrovatskii, S. I. (Akademiya Nauk SSSR, Moscow. Institut Fiziki). Translated from Preprint No. 83. 40p. CFSTI.

The problem of magnetic-acceleration (synchrotron) emission at helical motion of relativistic electrons emitting from a source with relativistic velocity is discussed and mathematically formulated. Problems of reabsorption of magnetobrems emission, with respect to radio emission by quasars, are reviewed, followed by a study of the motion of particles in a magnetic field in the presence of losses. Special emphasis is placed on this motion for particle aggregates of high energy density and the resultant changes in the magnetic field, with formulas for the change in energy of the particle group. Errors in formulas and conclusions by other authors are analyzed. (auth)

23913 PREFERENTIAL ACCELERATION OF HEAVY NUCLEI IN THE PROCESS OF GENERATION OF SOLAR COSMIC RADIATION. Kurnosova, L. V.; Razorenov, L. A.; Suslov, A. A.; Syrovatskii, S. I.; Fradkin, M. I. Kosm. Issled., 5: 863-73 (Nov.-Dec. 1967). (In Russian).

Cases of the increase of the current of different groups of nuclei, associated, probably, with their generation in the Sun, are described. In a series of cases, the greatest comparative increase of the current was observed for very heavy nuclei. A quantitative description of such cases, based on the dependence of the "runaway" ion current on their mass, is proposed. (tr-auth)

23914 OBSERVATION OF THE RADIOEMISSION OF THE SUN AT LONG WAVE LENGTHS BY MEANS OF LUNA-11 AND LUNA-12. Slysh, V. I. Kosm. Issled., 5: 897-910(Nov.-Dec. 1967). (In Russian).

The results of the observation of radio emission by type-III solar flares at frequencies of 1 MHz, 2 kHz, and, probably, 30 kHz by Luna-11 and Luna-12 are reported. Localization of the source of the radioemission by two independent methods (modulation of the rotation and observation of the lunar coating) made it possible to measure the velocity of the motion of the source: 0.4 to 0.5 c. The sources of the radio emission at 1 MHz and 200 kHz were located significantly further from the Sun than could be expected in combination with optical and rocket measurements of the electron concentration. The difficulty of the interpretation of the results in the framework of the plasma mechanism of flares of type-III was noted. In a series of cases an increased radio emission of the noise-storm type was observed at a frequency of 200 kHz. (tr-auth)

23915 REGISTRATION IN THE SPACE AROUND THE MOON OF ELECTRONS WITH ENERGY ABOVE 30 keV. Grigorov, N. L.; Lutsenko, V. N.; Maduev, V. L.; Pisarenko, N. F.; Savenko, I. A. Kosm. Issled., 5: 891-6(Nov.-Dec. 1967). (In Russian).

A current of electrons with energy above 30 keV was recorded by Sputnik Luna-11. The apparatus, consisting of gas discharge counters with magnetic filters and scintillation counters, is described. The results of the measurement of the electron current on September 1 and 8, 1966, when a temporary increase of the electron intensity was detected, are examined. (tr-auth)

23916 DIFFUSION OF ELEMENTS IN THE SUN. Delcroix, Andre; Grevesse, Nicolas (Univ., Liege). Compt. Rend., Ser. A and B, 266: 356-8(Feb. 5, 1968). (In French).

The diffusion of the elements from Li to Bi was studied systematically and the effect of this phenomenon on the observed element abundances was examined. The results are shown as the variation of the diffusion rate and of the Ci coefficient (actual abundance/initial abundance) as a function of the atomic number. Comparison of the solar abundances observed with meteorite abundances of the same elements seem to confirm qualitatively the results of the figure. Five sources of error in the calculation are indicated. (J.S.R.)

23917 SOLAR COSMIC-RAY FLARES AND RELATED SUNSPOT MAGNETIC FIELDS. Sakurai, Kunitomo (Kyoto Univ.). Rep. Ionosphere Space Res. Jap., 21: 113-24(Sept. 1967).

The cause of solar cosmic-ray flares is closely connected with the magnetic configuration and rotating motion of the sunspot groups wherein such flares take place. Taking into consideration that the rotational motion of sunspot groups, both anticlockwise and clockwise, is driven by the upward convective motion near the photospheric surface, the magnetic lines of force extending over the sunspot groups are strongly twisted by this convective motion. This twisting produces magnetic fields transverse to the initial magnetic flux tube. As a consequence, the transverse magnetic energy is gradually stored within the flux tube and then causes the onset of an instability such as the twisted one, the result of which is a solar cosmic-ray flare. With the development of the flare, the stored magnetic energy is promptly released through the untwisting process of the magnetic flux tube. For the period that sunspot groups are alive, the twisting of magnetic lines of force continuously proceeds by the rotational motion. Accompanying the development of instability, the severing of the magnetic flux tube occurs over the sunspot groups, by which the looped magnetic cloud is produced. This cloud moves upward through the solar corona and is lastly ejected into the interplanetary space. The magnetic flux tube that is tightly rooted within the sunspot groups is rapidly compressed due to this severing. At that time, some of the particles being trapped within this flux tube are accelerated to become solar cosmic rays. (auth)

23918 ESTIMATE OF THE MAGNITUDE OF THE REGULAR INTERPLANETARY MAGNETIC FIELD FROM THE ANISOTROPIC STAGE OF COSMIC-RAY BURSTS. Shishov, V. I. (Lebedev Inst. of Physics, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.), 7: 582(1967).

Translated from Geomagn. Aeron., 7: 716(1967).

High-energy solar protons are known to be essentially guided by the lines of force of the regular interplanetary magnetic field. An estimate of the magnetic field in the vicinity of the Earth was obtained, which is averaged over an interval approximately equal to the Larmor radius 10^{12} cm. (W.D.M.)

23919 NATURE OF FAST ELECTRONS IN THE SOLAR ATMOSPHERE. Martyshchenko, O. I. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio-Wave Propagation, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.), 7: 476-80(1967).

Translated from Geomagn. Aeron., 7: 586-91(1967).

The following possibilities for the formation of fast electrons in solar flares are examined: (a) the formation of δ electrons upon deceleration of fast particles in the region of the flare, and (b) formation of fast electrons as a result of the ionization of energetic particles as they accelerate. (auth)

23920 PARKER'S SOLAR WIND THEORY. II. FLOW WITH A HEAT SOURCE DEPENDING ON A POINT. Konyukov, M. V. (Lebedev Inst. of Physics, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.), 7: 469-75(1967).

Translated from Geomagn. Aeron., 7: 577-85(1967).

The influence of the strength distribution of a three-dimensional heat source on the properties of stationary plasma flow out of the Sun is examined. It is shown that when small areas of the corona are heated directly, the resultant flows have a temperature distribution that is at variance with observational data. (auth)

23921 SPICULES AS A POSSIBLE ORIGIN OF SMALL-SCALE INHOMOGENEITIES IN THE SOLAR CORONA AND IN

INTERPLANETARY PLASMA. Vitkevich, V. V. (Lebedev Inst. of Physics, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.), 7: 578-9(1967).

Translated from Geomagn. Aeron., 7: 712-13(1967).

Recent scintillation observations and solar wind studies made it possible to determine reliably the characteristic dimension of inhomogeneities. A possible cause of the inhomogeneities, i.e., spicules and closely associated phenomena, is discussed. (W.D.M.)

23922 STRUCTURE OF THE INTERPLANETARY MAGNETIC FIELD. Danilov, A. A. (Inst. of Cosmophysical Investigations and Aeronomy, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.), 7: 514-17(1967).

Translated from Geomagn. Aeron., 7: 632-6(1967).

Some results are reported of a study of cosmic rays and terrestrial magnetism, as well as of the structure of the interplanetary magnetic field in the plane perpendicular to the plane of the ecliptic. (auth)

23923 DISCOVERY OF THE FIRST TWO MASSES FORMED BY COMPACT GALAXIES. Zwicky, Fritz (Mount Palomar Observatory, Calif.). Compt. Rend., Ser. A and B, 266: 103-5(Jan. 8, 1968). (In French).

Of 10,000 galaxy masses, there are only two, up to the present, that are constituted principally by compact galaxies. (tr-auth)

23924 EVOLUTION OF THE SPECTRUM OF THE NOVA DELPHINI 1967. Fehrenbach, Charles; Andrillat, Yvette; Bloch, Marie. Compt. Rend., Ser. A and B, 266: 106-9(Jan. 8, 1968). (In French).

The observation of Nova Delphini 1967, whose spectrum was described previously, was continued. The spectral variations observed between July 10 and October 15, 1967 are reported. In the short-wave-length region $\lambda < 5000$ Å, the variations are considerable because of the spectacular augmentation of the emission lines and principally of absorption lines of Ti II. In the visible and infrared regions the change is much less apparent. (J.S.R.)

23925 IDENTIFICATION OF A FORBIDDEN LINE OF Ca II IN THE SOLAR SPECTRUM. Grevesse, Nicolas; Swings, Jean-Pierre (Univ., Liege). Compt. Rend., Ser. A and B, 266: 110-12(Jan. 8, 1968). (In French).

The forbidden line λ 7323,88 Å of Ca II was identified in the spectrum of the solar photosphere. The abundance deduced from its equivalent length, log N (Ca) = 6.01 (in the base log N(H) = 12,00), is in good agreement with the abundance obtained from the permitted lines of Ca I. (tr-auth)

23926 COSMIC RAYS AND SOLAR ACTIVITY. Charakhch'yan, A. N.; Charakhch'yan, T. N. Geofiz. Byull, A, No. 17, 3-19(1966). (In Russian).

For solar protons registered on Earth two kinds of differential energetic spectra with index values grouped around 3.0 for one class and 6.0 for the other are found. The first is related to diffuse propagation in space, the other to corpuscular streams towards the Earth. Time dependence of intensity of received radiation is related to the diffuse propagation, with a fairly close square-root dependence on proton impulse. The kinetic energy of the proton stream is 10^{29} erg. Galactic cosmic rays are also discussed, and a correlation between experimental and theoretical results for spatial and time modulations is found. The radius of the sphere around the Sun varies with solar activity, related to the number of spots by an exponential parameter; the radius has recently (1962) been about 7 au. The coefficient or diffusion of cosmic radiation is also a function of the number of spots. Full intensity of galactic radiation on Earth at the end of 1964 was 90 to 95% of its maximum intensity. The corresponding value for differential intensity was 85 to 90%. For the period of minimum solar activity there is poor correspondence between spectral distribution of cosmic radiation on the earth and at the limits of interplanetary space. (BBB)

23927 COSMIC EVOLUTION. Jastrow, Robert (Goddard Space Flight Center, New York). Natur. Hist., 77: 32-9(Jan. 1968).

The origin and evolution of stars are considered, along with formation of planets and development of organic life on earth. Evidence discovered in 1966 confirmed that the Universe began its existence ~10 billion yr ago as a dense, hot globule of gas, expanding rapidly outward. At that time the Universe contained only hydrogen. When the universe was about 100 million yr old, stars began to condense out of the primordial hydrogen and continued to form as the Universe aged. The Sun arose ~4.5 billion yr ago, when the Universe was about 5 billion yr old. Many stars developed before the Sun was formed and others after the Sun appeared. This process continues, with stars forming out of compressed pockets of gas in outer space. When a star begins to form as a dense cloud, the individual atoms fall toward the center of the cloud under the force of gravity; as they fall, they pick up speed, and their energy increases. The increase in energy heats the gas, and after this process has continued for some millions of years, the temperature reaches about 20 million °F. At this temperature the hydrogen within the star ignites and burns in a continuing series of nuclear reactions. The onset of these reactions marks the birth of the star. When a star's hydrogen becomes exhausted, its life nears an end, the first signs of old age being seen as a swelling and reddening of its outer regions. Such an aging, swollen star is called a red giant. The Sun will swell to a red giant in ~5 billion yr, vaporizing the earth. After the last of its hydrogen fuel is exhausted, a star collapses under the force of its own weight. If it is small, it collapses gently and remains as a "white dwarf." For a large star, final collapse is a cataclysmic event that generates a violent explosion, blowing its inner contents into space. Dispersed into space, the materials of the exploded star mix with the primeval hydrogen of the Universe. Later in the history of the Galaxy, other stars may be formed out of this mixture. (BBB)

23928 COMMENTS ON THE RELATION BETWEEN UM REGIONS AND GEOMAGNETIC DISTURBANCES. Bednarova-Nobakova, Bohumila (Geophysical Inst., Prague). Geofys. Sb., 13: 433-40(1966). (In Czech)

On the basis of data collected at the Geophysical Institute, CSAV, the solar situations during UM regions in 1953–1954 were studied. The series of UM regions investigated was divided into 3 groups: (1) a group of UM regions without other polarities being present and always followed by higher Ap indices; (2) a group of BM regions that were quiet without important changes, i.e., regions during which a bipolar field remains constantly on the CM and which are followed by a decrease of Ap indices; and (3) a group of BM regions of an eruptive character, for which (judging by the changes in filaments and fine chromospheric structure) considerable changes can be assumed in the magnetic fields—a flare is not always present, and it is followed by an increase of Ap indices. All three cases can be explained on the basis of the hypothesis of a coronal formation connected with characteristic types of filaments in each of these regions. Thus, the connection of the UM regions with geomagnetic disturbances and their disappearance during the occurrence of the BM regions is explained. (ATD)

23929 X-RAY EVENTS AT THE END OF AUGUST 1966. Takao, Kazuaki (Kyoto Univ.). Rep. Ionosphere Space Res. Jap., 21: 125-31(Sept. 1967).

By the real time telemetry of the solar radiation monitoring satellite, Explorer 30, interesting solar x-ray events were observed at Kyoto University at the end of August, 1966. Analysis of the time variation shows a relation between the x-ray and other terrestrial phenomena. Existence and nonexistence of the correspondence of SID's to x-ray bursts are discussed. (auth)

23930 ORIGIN OF THE DIFFUSE INTERSTELLAR ABSORPTION BANDS. Duley, W. W. (York Univ., Toronto). Nature (London), 218: 153(Apr. 13, 1968).

There is considerable interest in the nature of interstellar grains. A grain consisting of a graphite core surrounded by a dirty ice mantle adequately accounts for the wavelength dependence of interstellar extinction and polarisation, but the source of the large number of diffuse interstellar absorption bands remains a problem. The present author points out a similarity between these bands and absorption features observed in the spectra of neutral atoms trapped in molecular crystals at low temperatures, and examines the suggestion that the bands are caused by "matrix isolated" atoms or molecules in the light of new experimental information concerning the trapping of atomic impurities in low temperature matrices of the rare gases, and concerning $4'S_0 \rightarrow 4'P_1^1$ transitions of Ca I. There are indications that much interstellar Ca is attached to interstellar grains, and that the resonance transition of Ca can be shifted and broadened sufficiently when Ca atoms are trapped in low-temperature molecular crystals to account for the wavelength and width of the 4430 Å interstellar band. It would be expected that other atoms could also be trapped in the dielectric mantles of interstellar grains, and the case of Na atoms is mentioned. (UK)

23931 OH ABSORPTION IN THE GALAXY. Goss, W. Miller (Univ. of California, Berkeley). Astrophys. J., Suppl. Ser., 15: 131-202(Jan. 1968).

A survey of northern hemisphere radio sources for 18-cm OH absorption was completed using the 85-foot Hat Creek telescope of the University of California. The observations were made with the 100-channel receiver with frequency resolutions of 10 kHz (1.8 km/s) and 2 kHz (0.36 km/s). Galactic OH absorption lines were found in 26 galactic sources and two extragalactic sources. Two H II regions which lie in the direction of W43 were identified

from their 158α H recombination lines. The 158α He line from the stronger of the two H II regions was detected. In many cases, it is possible to compare the OH absorption lines observed in this investigation with the H I absorption lines found by other observers. The general agreement in velocity suggests that the OH has a distribution similar to that of the H I. The solution of the equation of transfer appropriate to the OH absorption case is presented. The importance of the isotropic background and the galactic background is stressed. The major processes establishing the excitation of OH in H I regions are considered. The level of excitation is controlled by (1) collisions with positive ions and electrons, and (2) the 18-cm isotropic radiation field (assumed to be 3°K). The calculations predict an excitation temperature of about 20°K, while the observational evidence indicates that the excitation temperature is less than about 10°K. Two possible causes for this discrepancy are discussed. For the purpose of the estimation of OH projected densities, it is assumed that the excitation temperature is 3°K (the lower limit). Based on this assumption the ratios of the OH to H I projected densities are in the range 10^{-8} to 10^{-7}. (auth)

23932 ABUNDANCES OF THE ELEMENTS IN THE SOLAR PHOTOSPHERE. II. SODIUM, ALUMINUM, PHOSPHORUS, SULPHUR, AND POTASSIUM. Lambert, D. L.; Warner, B. (Oxford Univ.). Mon. Notic. Roy. Astron. Soc., 138: 181-212 (1968).

A comprehensive account is given of the available data on solar absorption lines arising from the above elements. The use of improved oscillator strengths for selected lines leads to a revision of the abundances of these elements. The final values, on the scale log N(H) = 12.00, are log N(Na) = 6.18, log N(Al) = 6.40, log N(P) = 5.43, log N(S) = 7.21, and log N(K) = 5.05. (auth) (UK)

23933 ABUNDANCES OF THE ELEMENTS IN THE SOLAR PHOTOSPHERE. III. SILICON. Lambert, D. L.; Warner, B. (Oxford, Univ.). Mon. Notic. Roy. Astron. Soc., 138: 213-27 (1968).

The solar photospheric abundance of silicon is derived from application of theoretical oscillator strengths for transition arrays of the type 3pns−3pn'p in Si I and 4s−4p in Si II. The two stages of ionization are in agreement and lead to log N(Si) = 7.55 on the scale where log N(H) = 12.00. Interpretation of the profiles of strong Si I lines is discussed and a modification of the solar model atmosphere is suggested. The [Si I] line at 10991.41 Å is found to be only a minor contributor to a blend with a telluric line. (auth) (UK)

23934 ABUNDANCES OF THE ELEMENTS IN THE SOLAR PHOTOSPHERE. IV. THE IRON GROUP. Warner, Brian (Oxford Univ.). Mon. Notic. Roy. Astron. Soc., 138: 229-43 (1968).

Abundances of the iron group elements are derived from ionic lines in the photospheric absorption spectrum. There is very good agreement with abundances found from neutral species for all except Co and Ni. The latter discrepancies are thought to arise from uncertainty in the absolute scales of the f values and from difficulties in interpretation of ultraviolet line strengths. The general good agreement supports the assumption of local thermodynamical equilibrium for the calculation of the ionization state of the solar photosphere. (auth) (UK)

23935 NONTHERMAL EMISSIVITY OF THE GALACTIC DISK NEAR $l^{II} = 140°$. Bridle, A. H. (Cavendish Lab., Cambridge, Eng.). Mon. Notic. Roy. Astron. Soc., 138: 251-8(1968).

An area of sky containing the ionized hydrogen regions IC 1795, IC 1805, and IC 1848, and the supernova remnant HB 3, was observed with the 10 MHz radio telescope at the Dominion Radio Astrophysical Observatory, Canada. The results imply that the brightness temperature of the non-thermal radio emission arising in the line of sight to the ionized hydrogen regions is between 85,000 and 140,000°K at this frequency. The mean nonthermal emissivity of the galactic disk in this direction ($l^{II} \approx 140°$) is estimated to be between 4.5 and 9×10^{-41} W m^{-3} $ster^{-1}$ Hz^{-1} at 10 MHz. This result is combined with measurements of the flux of primary cosmic-ray electrons at the top of the Earth's atmosphere to estimate the strength of the interstellar magnetic field in this region of the disk. It is suggested that the supernova remnant HB_3 is of exceptional linear size. (auth) (UK)

23936 OBSERVATIONS OF THE STRUCTURE OF RADIO SOURCES IN THE 3C CATALOGUE. I. Macdonald, G. H.; Kenderdine, S; Neville, Ann C. (Cavendish Lab., Cambridge, Eng.). Mon. Notic. Roy. Astron. Soc., 138: 259-311(1968).

The Cambridge one-mile radio telescope was used to map the structure of 82 extended extragalactic radio sources from the 3C catalogue with beamwidths of 80″ arc and 23″ arc at 408 and 1407 MHz respectively. Contour maps of the sources are presented, together with a list giving the position, angular size, flux density, and spectral index of each separate component; brief descriptions of possibly related optical objects based upon the Sky Survey prints are also included. (auth) (UK)

23937 COSMOLOGICAL MODELS WITH PRESSURE. Stabell, Rolf (Univ. of Illinois, Urbana). Mon. Notic. Roy. Astron. Soc., 138: 313-23(1968).

The effect of introducing pressure on relativistic cosmological models was investigated. The investigation was carried out for the case where a polytropic relation between the pressure and the density exists, and in the special case where the pressure is proportional to the density. When pressure is introduced some of the models are reclassified. It is shown that the radial distance, and hence all the cosmological parameters that are functions of this distance, are affected. As an example the apparent magnitude−red shift relation for a model with zero and nonzero pressure is shown. It is found that the introduction of pressure always tends to decrease the traveltime of light from an object and the age of a Universe model. (auth) (UK)

23938 EFFECTS OF ACCRETION ON WHITE DWARF STARS. Saslaw, William C. (Cambridge Univ., Eng.). Mon. Notic. Roy. Astron. Soc., 138: 337-58(1968).

When a white dwarf accretes hydrogen-rich material, a shell of hot degenerate nuclear fuel may build up. Energy generation becomes important, causing the shell to become secularly unstable, and it may then flash. Time scales and energy generation rates are computed using the initial temperature of the core and the accretion rate as main parameters of the theory. There is a critical initial temperature (which slowly increases with increasing accretion rate) below which the shell will eventually flash. Above this critical temperature the energy generation reaches a steady state. Temperatures on both sides of the critical point are investigated. The temperature range is from 1×10^7 to 1×10^8°K, and accretion rates are between 2×10^{14} and 2×10^{24} g/s. Maximum energy generation rates vary from 10^{34} to more than 10^{45} erg/s, and time scales for energy generation vary between about 0.5 days and 3×10^7 years. Small departures of the core from isothermality will be significant, and a detailed model is suggested to describe such conditions. Classes of observed objects in which accretion may be relevant are considered. Recurrent novae, dwarf novae, symbiotic stars, and x-ray stars such as Sco X−1 are the most likely candidates for systems in stages where effects of accretion are important. Some planetary nebulae may already have evolved through such a phase. (auth) (UK)

23939 AXISYMMETRIC DYNAMO. Jayanthan, R. (Univ. of Michigan, Pontiac). Mon. Notic. Roy. Astron. Soc., 138: 477-94(1968).

The problem of the steady axisymmetric dynamo is reconsidered, and it is shown that the theorems of Cowling and Backus and Chandrasekhar prohibiting the axisymmetric dynamo process are valid only if the magnetic fields are continuous and continuously differentiable everywhere. The "eigenvalue" theory of Elsasser and Bullard is briefly discussed; it is shown that a unique real eigenvalue must exist and that the usual assumption of convergence of the eigenvalue to some limit for a finite set of equations throws serious doubt on the validity of the formulation of the theory. A dynamo model in a spherical coordinate system with symmetry about an axis is developed. The model has the following properties: (a) the currents generating the magnetic field flow along latitude circles and are not continuous on the bounding surface; (b) the magnetic field in the exterior current-free region is a dipole field; (c) the states of isorotation include the law of rotation observed at the solar surface. The analysis brings out a striking resemblance between the model considered here and proposed by Larmor in 1934 on purely physical grounds. An approximate stability analysis shows that this dynamo process is stable to a perturbation where the velocity field maintaining the dynamo is increased or decreased at all points in the fluid by a constant factor. It is concluded that the proposed model of the dynamo is the only possible model with spherical geometry which allows a nonuniform rotation which does not distort the magnetic field. (auth) (UK)

23940 DETERMINATION OF THE EVOLUTIONARY PROPERTIES OF QUASARS BY MEANS OF THE LUMINOSITY-VOLUME TEST. Rowan-Robinson, M. (Univ. of Sussex, Eng.). Mon. Notic. Roy. Astron. Soc., 138: 445-75(1968).

A cosmological test suitable for sources with a large dispersion in luminosity, the luminosity−volume test, is described. Application to both the optical and radio data for quasars, assuming their redshifts to be cosmological, shows that none of the relativistic models can apply without some evolutionary factor that affects both

radio and optical properties. Simple evolutionary hypotheses are tested, and it is found that only relatively empty models ($4\pi G\rho_0 \ll H_0^2$) with $-1 \leq q_0 \leq 0.5$ are consistent with power-law luminosity–evolution, whereas all models are consistent with density–evolution. Evolutions with a negative exponential dependence on the scale factor, which do not require a truncation of the evolving population at finite red shift to give a finite integrated background radiation, represent the data well. The test should be applicable to radiogalaxies when the data are more complete. (auth) (UK)

23941 DELTA SCUTI STAR HD 116994. Chambliss, C. R. (Australian National Univ., Canberra). Mon. Notic. Roy. Astron. Soc., 138: 437-43(1968).

The recently discovered Delta Scuti-type variable HD 116994 was observed photoelectrically in three colors. The period of the star is about 0.1022^d, and its amplitude is about 0.25^m in V, although both are subject somewhat to phase and amplitude distortions. The B–V curve is in phase with the light variations while the U–B curve is more or less 180° out of phase with the light variations as is typical for Delta Scuti-type stars. HD 116994 is very similar in most respects to the star CC Andromedae. (auth) (UK)

23942 PRECISE MEASUREMENTS OF THE FLUX DENSITIES OF THE RADIO SOURCES CAS A AND CYG A AT METRE WAVELENGTHS. Parker, E. A. (Cavendish Lab., Cambridge, Eng.). Mon. Notic. Roy. Astron. Soc., 138: 407-22(1968).

The flux densities of Cas A and Cyg A were measured at 38.0, 81.5, and 152.0 MHz with estimated errors of less than 4%, a substantial improvement in accuracy over previous determinations in this frequency range. Results are also given for Tau A at 81.5 and 152.0 MHz. A comparison with flux densities measured at higher frequencies shows that Cas A has a constant spectral index of 0.770 ± 0.006 between 38.0 MHz and 15.5 GHz. (auth) (UK)

23943 RADIO SOURCE STRUCTURE DERIVED FROM INTERPLANETARY SCINTILLATION. Little, L. T.; Hewish, A. (Cavendish Lab., Cambridge, Eng.). Mon. Notic. Roy. Astron. Soc., 138: 393-406(1968).

It is possible to derive information concerning the angular structure of radio sources in the range 0.1″ to 1″ by making systematic observations of their interplanetary scintillation. A survey of sources from the 3C Revised Catalogue was made at Cambridge at a frequency of 178 MHz and the observations and analysis of the data from the survey are described. The conclusions relating to the structure of the individual sources are presented and compared with results obtained by other methods, where these are available. (auth) (UK)

23944 COSMOGONIC FRAGMENTATION. Bird, J. F. (Johns Hopkins Univ., Silver Spring, Md.). Nature (London), 217: 1239-40(Mar. 30, 1968).

It is stated that many hypotheses concerned with the evolution of cosmic systems call for some mechanism for fragmenting cosmic masses. The present communication discusses one possible fragmentation mechanism—gravitational instability in anisotropic expansion—which can operate effectively under diverse hypotheses. It is argued that this is a feasible mechanism in that (a) linear instability can be strong, (b) nonlinearities need not debar permanent fragmentation, but (c) they can control excessive subfragmentation. Some hypotheses yielding anisotropic expansion are indicated, with special reference to star formation. Gravitational stability theory indicates that anisotropic expansions can permit exponential growth of density fluctuations, in contrast to the weak algebraic instabilities of a spherical expression. The essential physical reason for this is that the density, and therefore the fluctuations of self-gravity, can decrease with time sufficiently slowly in anisotropic expansion. These concepts are discussed on a physical and mathematical basis. (UK)

23945 IS INTERSTELLAR HYDROGEN CAPABLE OF MASER ACTION AT 21 cm? Stormer, S. H.; Sciama, D. W. (Cambridge Univ., Eng.). Nature (London), 217: 1237-9(Mar. 30, 1968).

Some observational suggestions that the density of interstellar neutral hydrogen may be less than the value usually inferred from 21-cm emission line measurements are discussed. Attempts have been made to resolve the discrepancies by invoking maser action in the 21-cm line of interstellar hydrogen, made possible by a population inversion of the hyperfine levels of the ground state arising from Lyman-α pumping. It is concluded from a detailed consideration of the Lyman-α pumping mechanism that it is unlikely to be of importance in resolving these problems. (UK)

23946 HEAVY RARE GASES FROM LEIGHTON CHONDRITE. Meason, J. L.; Rao, M. N. (Univ. of Arkansas, Fayetteville). J. Geophys. Res., 73: 2297-8(Mar. 15, 1968).

Light and dark phases of the Leighton meteorite were mechanically separated, gas was extracted from dark phases and purified in a system having an initial pressure of 5×10^{-8} mm Hg, and a mass-spectrometric analysis of rare gases was performed. The abundance of each isotope of xenon and krypton is tabulated and compared with atmospheric abundance. The $^{129}Xe/^{130}$ ratio found is very high compared with other bronzite chondrites. This large excess of ^{129}Xe seems to be associated with a large abundance of iodine. The composition of the light isotopes of Xe does not indicate any contribution from spallation reactions, and the heavy isotopes of Xe seem to be similar to the primordial composition. All krypton isotopes seem to be present in excess over the atmosphere, but measurement errors may be large. The excess of ^{86}Kr found seems to be similar to that of the Fayetteville meteorite. (A.G.W.)

23947 DETECTION PRINCIPLE FOR PHOTOELECTRIC POLARIZATION MEASUREMENTS ON FAINT STELLAR OBJECTS. Wiedling, T. (Stockholm Observatory). Ark. Astron., 4: 349-56(1967).

Since interstellar polarization effects are comparatively small there are experimental difficulties in measuring star-light polarization accurately. Even minor background effects may completely mask the polarization. An electronic technique applicable to polarization measurements is described. Principally it is a filter with a very small pass band and it is mainly to be used in photon counting on faint objects. The technique is also applicable in multicolor photometry and spectrometry. (auth) (Sweden)

23948 SPECTROGRAPHIC OBSERVATIONS OF DARK SURGES AND MOTTLES AT THE SOLAR LIMB. Oehman, Y. (Swedish Solar Observatory, Anacapri, Italy). Ark. Astron., 4: 317-18(1967).

By using the Babcock grating at the Swedish Solar Observatory in Anacapri some observations were made of the chromospheric Hα line at the limb using a tangential slit. In images of good definition nonsymmetrical absorption effects were traced indicating dark surges and mottles. This suggests a method for observing such objects at the limb. A comparison is made also of chromospheric spectra and the spectra of flares. (auth) (Sweden)

23949 INVESTIGATION OF A MILKY WAY FIELD IN SCORPIUS. VI. A PHOTOELECTRIC SEQUENCE OF A–K STARS. Roslund, C. (Univ. of Lund, Sweden). Ark. Astron., 4: 341-7(1967).

A sequence of twelve stars of spectral types AO and later and of an apparent brightness V ranging from 10.5 to 13.3 mag. were set up photoelectrically in the UBV system at R. A. $17^h09^m.5$ and Dec. –33° 12 min (1950). Thirteen additional stars taken from the Henry Draper and Henry Draper Extension Catalogues were measured in the field surrounding the sequence. A renewed discussion of extinction data for the atmosphere of the Earth, published in Paper I of this series of investigations, together with new extinction determination, shows that the origin of the air mass prevailing at the time of observation is the determining factor for the transparency of the sky above the Boyden Observatory. (auth) (Sweden)

23950 INTERPRETATION OF COSMIC MICROWAVE BACKGROUND. Narlikar, J. V.; Wickramasinghe, N. C. (Cambridge Univ., Eng.). Nature (London), 217: 1235-6(Mar. 30, 1968).

The discovery of microwave background radiation is stated to be one of the most interesting events in observational astronomy in recent years. This radiation has been interpreted as of black-body type and as a remnant of the primordial radiation associated with a "big-bang" universe. It is claimed that the radiation corresponds to a temperature of 2.68°K, and that its intensity fits black-body better than the "grey-body" approximation at long wavelengths. The present communication examines this interpretation in the light of available information concerning the Universe. The possibility of other processes operative in the Universe capable of producing a microwave background of the observed magnitude is examined. One such process has been suggested, consisting of absorption of optical and uv radiation from stars, and its reradiation at longer wavelengths, by impurity oscillators in interstellar dust grains. The problem of the redshift effect is also examined, both in relation to the steady state model and the "big-bang" model. The order of magnitude of the radiation is discussed, particularly in regard to observational frequency range. It is considered that the interstellar dust process could make a substantial contribution to the microwave background, although it is not suggested that this is the only source of the radiation. With regard to the cosmological aspects of the problem it is considered that the black-body explanation may have been overstated, and that it is premature to conclude that the steady-state theory is untenable. (UK)

23951 RAPIDLY PULSING RADIO SOURCES. Saslaw, William C.; Faulkner, John; Strittmatter, Peter A. (Cambridge Univ., Eng.). Nature (London), 217: 1222-7(Mar. 30, 1968).

The gravitational lens effect associated with a neutron star binary gives results which agree well with recent observations of a new class of rapidly pulsing radio sources. Further tests of the theory are proposed. (auth) (UK)

23952 POPULATION TYPE OF CYGNUS X-2. Sofia, S.; Wilson, R. E. (Univ. of South Florida, Tampa). Nature (London), 218: 73-4(April 6, 1968).

There has been considerable controversy concerning the population type of Cyg X-2. It is shown that unless there is gross violation of the mass–luminosity relation the population kinematics must be intermediate between types I and II. If accretion on a white dwarf is the x-ray generating mechanism this conclusion is independent of the mass–luminosity relation. The intermediate population type suggested for the point x-ray sources is not surprising, since their distribution in galactic latitude is definitely (but not highly) condensed about the galactic equator. It is interesting that the old novae also have an intermediate population distribution. The question of whether Cyg X-2 is binary or at least tertiary is also mentioned. (UK)

23953 OBSERVED LIMITS TO THE CIRCULAR POLARIZATION OF NINE QUASARS AT RADIO FREQUENCIES. Komesaroff, M. M.; Gardner, F. F.; Morris, D.; Roberts, J. A.; Whiteoak, J. B. (CSIRO, Sydney). Nature (London), 218: 73(April 6, 1968).

It has been suggested that the radio emission of compact quasars will show appreciable circular polarization ($\gtrsim$1%) at frequencies <1,000 MHz. This suggestion is based on assumed magnetic fields within the variable components as large as 1 to 100 G. Measurements are reported in this paper of the circular polarization of nine quasars and 37 radio galaxies and unidentified sources at 437, 630, and 1,410 MHz. In no case was any significant component of circular polarization detected. (UK)

23954 FAN-BEAM OBSERVATIONS OF RADIO SOURCES AT 408 AND 1407 MHz. Bailey, J. A.; Pooley, G. G. (Cavendish Lab., Cambridge, Eng.). Mon. Notic. Roy. Astron. Soc., 138: 51-66(1968).

The Cambridge One-Mile Radio Telescope was used in a one-dimensional synthesis to survey the radio sources in areas near $\delta = 50°$ totalling 0.15 steradians. The effective beamwidths between half-power points at 408 and 1407 MHz respectively were 100″ and 30″ arc in declination and 2°.5 and 50′ arc in right ascension. At 408 MHz some 200 sources having $S_{408} \geq 0.5 \times 10^{-26}$ W m^{-2} Hz^{-1} were observed, and their declinations measured with an accuracy of $\simeq 10''$. At 1407 MHz sources within a smaller area of sky and having $S_{1407} \geq 0.3 \times 10^{-26}$ W m^{-2} Hz^{-1} were observed. Among the sources were 82 from the 4C catalogue, and the improved positional accuracy in declination has enabled a new search to be made for related optical objects. The results are being combined with those from the 5C surveys to derive the N(S) relation for $S_{408} \geq 10^{-26}$ W m^{-2} Hz^{-1}. (auth) (UK)

23955 ADIABATIC PULSATIONS AND CONVECTIVE INSTABILITY OF GASEOUS MASSES. III. Tassoul, Jean Louis (FNRS, Belgium). Mon. Notic. Roy. Astron. Soc., 138: 123-36 (1968).

The nonradial adiabatic pulsations of a homogeneous gas sphere pervaded by a weak magnetic field which vanishes on the boundary is investigated on the basis of the third-order virial equations. It is shown that Prendergast's magnetic field partially removes the degeneracy in the frequency spectrum. It increases the acoustic and Kelvin frequencies belonging, respectively, to the spherical harmonics $l = 1$ and $l = 3$. Convective instability associated with the harmonics $l = 1$ can be suppressed only if the adiabatic exponent is sufficiently large. In the limiting case of a fluid sphere, the system is thoroughly stable. As for the compressible configuration, the magnetic field increases the Kelvin frequencies and allows purely hydromagnetic modes with periods much larger than those associated with the Kelvin modes. (auth) (UK)

23956 ABUNDANCES OF THE ELEMENTS IN THE SOLAR PHOTOSPHERE. I. CARBON, NITROGEN, AND OXYGEN. Lambert, D. L. (Oxford Univ.). Mon. Notic. Roy. Astron. Soc., 138: 143-79(1968).

The determination of the abundances of carbon, nitrogen, and oxygen in the solar atmosphere is discussed from an analysis of atomic and molecular spectra. A detailed discussion of the neutral atomic spectra is presented. Five molecular bands are considered: C_2 Swan Band, CN red and violet systems, CO first overtone bands, and the CH ($A^2\Delta - X^2\Pi$) band. With the exception of the CH band the analysis of the molecular bands yields abundances which are in good accord with the results from the neutral atomic spectra. The following abundances are derived: $\log A_C = 8.55$, $\log A_N = 7.93$, and $\log A_O = 8.77$ on the standard scale $\log N_H = 12.00$. (auth) (UK)

23957 WAVELENGTH DEPENDENCE OF INTERSTELLAR OBSCURATION OF WOLF-RAYET STARS. Reddish, V. C. (Royal Observatory, Edinburgh). Mon. Notic. Roy. Astron. Soc., 138: 535-6(1968).

Interstellar obscuration exhibited by many Wolf–Rayet stars may be partly, and possibly largely, circumstellar. It was thus of interest to determine the wavelength dependence of this obscuration, as a method of investigating the properties of the dust in such circumstellar clouds. The method adopted was differencing the measures on pairs of stars with similar time spectra, in which one is more reddened by interstellar obscuration than the other. The results confirm that this reduces the effect of residual spectrum time features. (UK)

23958 OBSERVATIONS OF SUNSPOTS USING SHEARING INTERFERENCE OF THE DIFFRACTION IMAGE. Oehman, Y. (Swedish Solar Observatory, Anacapri, Italy). Ark. Astron., 4: 319-22(1967).

Observations of sunspots are reported when interference of the diffraction image of the telescope is produced. The images show a different shape for different phase differences between the two superimposed images in good agreement with previous calculations. An influence of atmospheric seeing is noticed indicating that the coherence in the diffraction image is somewhat destroyed sometimes by bad seeing. (auth) (Sweden)

23959 POSSIBLE MODEL FOR A RAPIDLY PULSATING RADIO SOURCE. Ostriker, Jeremiah (Princeton Univ., N. J.). Nature (London), 217: 1227-8(Mar. 30, 1968).

The pulsating radio signals may come from active regions on rapidly rotating white dwarf stars. This could account for some aspects of the periodicity of the signals which are difficult to explain if the sources are pulsating stars. (auth) (UK)

23960 OBSERVABILITY OF THE 3 cm LINE OF HYDROGEN DURING SOLAR FLARES. Berger, Richard A.; Malville, J. McKim (Univ. of Michigan, Ann Arbor). Publ. Astron. Soc. Pac., 78: 343-5(Aug. 1966).

A determination as to whether or not the 3-cm line of hydrogen arising from the fine structure transition $2^2P_{\frac{3}{2}} - 2^2S_{\frac{1}{2}}$ might be produced in flares with measurable intensity by estimating the line-to-continuum ratio during a flare was considered. The model atom used in the calculations is shown. Since its levels are close in energy, and since collisional processes between the levels predominate at chromospheric densities, the levels are thought to be populated approximately according to their statistical weights. (IAA)

23961 CONTINUED SEARCH FOR THE VENUS AIRGLOW. Goody, Richard (Harvard Univ., Cambridge, Mass.); McCord, Thomas. Planet. Space Sci., 16: 343-51(Mar. 1968).

An attempt was made to detect the airglow on Venus by means of differential photometric scans across the dark limb. No airglow was detected placing an upper limit of 100 kR on individual lines or 0.5 kR/Å on the continuum. The upper limit was imposed by scattered light in the telescope optics and the wide filters (200 Å) employed. A great improvement would be possible with a specially designed telescope and narrower filters. There is no difficulty in principle in proceeding to the limit imposed by photomultiplier noise, possibly to less than 100 R. (auth) (UK)

23962 ACCURATE POSITION OF A SECOND PULSED RADIO SOURCE. Bailey, J. A.; Mackay, C. D. (Cambridge Univ., Eng.). Nature (London), 218: 129-30(Apr. 13, 1968).

The Cambridge one-mile telescope was used to fix the position of a second pulsed radio source. There is no obvious identification with an optical source. (auth) (UK)

23963 COUNTS OF RADIO SOURCES AT 2,700 MHz. Pooley, G. G. (Cambridge Univ., Eng.). Nature (London), 218: 153-4 (Apr. 13, 1968).

It was claimed that radio-source counts having a slope of –1.4, derived by Shimmins et al. (Nature 217: 818 (1968)), on the basis of some new observations made in Australia at 2,700 MHz, differed significantly from Cambridge results, and cast doubt on the validity of the interpretation of the counts in terms of evolutionary cosmological models. The present author refutes these doubts and points out that there is little discrepancy between the Australian observations and the Cambridge source counts made at 178 and 408 MHz; discrepancies may be due to statistical uncertainties arising from the small number of sources in the limited area of sky so far observed at 2,700 MHz. Relevance to the steady state model of the Universe is discussed. (UK)

23964 LINEAR POLARIZATION IN PULSATING RADIO SOURCES. Lyne, A. G.; Smith, F. G. (Univ. of Manchester, Jodrell Bank, Eng.). Nature (London), 218: 124-6(Apr. 13, 1968).

Signals from all the known radio sources are linearly polarized. The pulses often appear to be made up of separate components showing a high degree of polarization. (auth) (UK)

23965 OBSERVATIONS OF SOME FURTHER PULSED RADIO SOURCES. Pilkington, J. D. H.; Hewish, A.; Bell, S. J.; Cole, T. W. (Cambridge Univ., Eng.). Nature (London), 218: 126-9 (Apr. 13, 1968).

Details are given of three of the four pulsating radio sources discovered at Cambridge. (auth) (UK)

23966 PULSED RADIO SOURCES. Hoyle, F.; Narlikar, J. (Cambridge Univ., Eng.). Nature (London), 218: 123-4(Apr. 13, 1968).

In connection with the problems raised by the discovery of rapidly pulsed radio sources, it is pointed out that pulses of energy may be emitted by collapsing supernovae in suitable circumstances. (auth) (UK)

23967 MAGNETIC BRAKING BY A STELLAR WIND. I. Mestel, L. (Univ. of Manchester, Eng.). Mon. Notic. Roy. Astron. Soc., 138: 359-91(1968).

The stellar wind theory is formulated for a rotating magnetic star, surrounded by an isothermal corona, and with the magnetic and rotation axes parallel. A critical surface C is defined by the Alfvénic points on each field-line at which the wind-speed just equals the local Alfvén speed. The limiting field-line, with its Alfvénic point on the equator, separates the wind zone (which includes the polar regions) from the dead zone, in which outward expansion is prevented by the magnetic pressure. Within C the roughly dipolar field is strong enough to force the flow to follow the field, and to keep the gas approximately co-rotating with the star. Beyond C, the gas flow drags the field to follow the flow, and each element approximately conserves its angular momentum. If the coronal temperature is too low for a thermal wind, the magnetically controlled centrifugal forces drive a centrifugal wind, so that there is again a surface C limiting the zone of co-rotation. The rate of mass-loss, $-\dot{M}$, and angular momentum loss, $-\dot{J}$, are found as functions of the coronal base density ρ_s, the star's rotation Ω_s, and three nondimensional numbers: 1, the ratio of gravitational to thermal energy density, ζ, the ratio of magnetic to thermal energy density, and κ, the ratio of centrifugal force to gravity, all three computed at the coronal base r_s. For $\zeta \gg 1$, $-\dot{J}$ varies slowly with ζ, but $-\dot{M}$ decreases sharply with increasing ζ, so illustrating Schatzman's suggestion that angular momentum loss per unit mass-loss may be greatly increased by magnetic control of the outflowing gas. When the corona is hot, $-\dot{J}/\Omega\, r_s^2$ is almost independent of κ — the wind is essentially thermal; but at lower temperatures it is high only when $\kappa \simeq 1$ — the wind is essentially centrifugal. The theory is applied to stars in thermal equilibrium, and to pre-main sequence stars contracting along the Hayashi and post-Hayashi tracks. In a close binary system of proto-stars, coupling between spin and orbital motion may be sufficiently strong to ensure that spin angular momentum lost is restored at the expense of the orbital angular momentum, so that the system remains a close binary in spite of the contraction of the individual stars. (auth) (UK)

23968 THE RADIO EMISSION FROM GALAXIES IN THE PERSEUS CLUSTER. Ryle, M.; Windram, M. D. (Cambridge Univ., Eng.). Mon. Notic. Roy. Astron. Soc., 138: 1-21(1968).

Observations of the Perseus cluster have revealed a remarkable interaction between the Seyfert galaxy NGC 1275 and two other galaxies NGC 1265 and IC 310, which lie at distances of about 600 kpc from NGC 1275. The interaction is almost certainly due to the incidence of relativistic particles ejected from the nucleus of NGC 1275 on the gaseous material in these other galaxies. Estimates of the minimum energy in the particle stream at epochs $\sim 5 \cdot 10^6$ years ago are compared with those derived from three radio components associated with NGC 1275 itself, and from a fourth more extensive source. The results suggest that ejection of relativistic particles from the nucleus has continued for the whole of this period, although the present rate is probably rather smaller than that $5 \cdot 10^6$ years ago. The total energy contained in the electronic component is at least $3 \cdot 10^{59}$ ergs, so that it is comparable with that released in the most powerful radio sources known. The acceleration of the particles may be related to a series of supernova events in the nucleus of NGC 1275, occurring at the present time at a rate of about one every 10 years. It seems possible that the source of energy in quasars and radio galaxies may be due to a similar process operating on a shorter time scale. (auth) (UK)

23969 COLLOQUIUM ON LATE-TYPE STARS. Proceedings of the Colloquium Held in Trieste, June 13-17, 1966. Hack, Margherita (ed.). Trieste, Italy, Osservatorio Astronomico, 1966. 467p. (In French and English). (CONF-660665).

Separate abstracts were prepared for 46 of the papers. Five papers are represented by abstracts only. (W.D.M.)

For abstracts of individual papers see: 23970–24015.

23970 GENERAL INTRODUCTORY ADDRESS TO THE COLLOQUIUM ON LATE-TYPE STARS. Swings, P. (Institut d'Astrophysique, Liege). pp 11-14 of Colloquium on Late-Type Stars. Trieste, Italy, Osservatorio Astronomico, 1966.

From Conference on Late-Type Stars, Trieste, Italy. See CONF-660665.

The history of the researches on late-type stars is summarized and the more important subjects of research in this field are stressed. (auth)

23971 FUTURE SPECTROSCOPY FOR LATE-TYPE STARS. Moore, C. E. (National Bureau of Standards, Washington, D. C.). pp 15-24 of Colloquium on Late-Type Stars. Trieste, Italy, Osservatorio Astronomico, 1966.

From Conference on Late-Type Stars, Trieste, Italy. See CONF-660665.

The subject is reviewed with the idea of the application of spectroscopy to work on abundances. Two main topics are discussed: the general characteristics of the observed stellar spectra and the available data on laboratory spectra needed to identify the stellar lines. The impact of the developments in space technology has greatly expanded the observed range of stellar spectra. This is handled by regions, the ultraviolet, the visible, and the infrared. More laboratory programs are needed to meet present needs for data on both atomic and molecular spectra. The existing programs are discussed. Encouraging progress on the analyses of selected rare-earth spectra is reported. These promise to be of great astrophysical interest. (auth)

23972 BROADENING OF THE 4226.73 A LINE ($4s^2\,{}^1S_0 - 4p^1\,{}^1P_1^0$) OF Ca I IN LABORATORY SPECTRA AND IN M-TYPE STARS. Weniger, S. (Observatoire de Paris, Meudon, France). pp 25-34 of Colloquium on Late-Type Stars. Trieste, Italy, Osservatorio Astronomico, 1966. (In French).

From Conference on Late-Type Stars, Trieste, Italy. See CONF-660665.

The absorption spectrum of calcium vapor, obtained in the graphite resistance furnace, was studied. In the visible region of the spectrum numerous bands degraded towards the short wavelengths and an evolution with the temperature of the profile of the resonance line ($4s^2\,{}^1S_0 - 4\,p^1\,{}^1P_1^0$) 4226.73 Å of Ca I were observed. As these results show some resemblance to the continuous absorption around the 4227 Å line of Ca I observed by Lindblad in the dwarf spectrum, plausible hypotheses for interpreting this phenomenon are discussed. (auth)

23973 REMARKS CONCERNING SPECTROSCOPIC OBSERVATIONS OF LATE-TYPE STARS. Wright, K. O. (Dominion Astrophysical Observatory, Victoria, B. C., Can.). pp 35-46 of Colloquium on Late-Type Stars. Trieste, Italy, Osservatorio Astronomico, 1966.

From Conference on Late-Type Stars, Trieste, Italy. See CONF-660665.

A brief review of current problems in the study of late-type stars is given: line identification, quantitative analysis, including the (Fe/H) ratio, stellar chromospheres, mass-loss, and emission lines observed in late-type spectra. (auth)

23974 APPROXIMATE ABUNDANCES OF THE LIGHT ELEMENTS FROM THE MOLECULAR SPECTRA OF M AND S GIANT STARS. Spinrad, H. (Univ. of California, Berkeley); Vardya, M. S. pp 47-8 of Colloquium on Late-Type Stars. Trieste, Italy, Osservatorio Astronomico, 1966.

From Conference on Late-Type Stars, Trieste, Italy. See CONF-660665.

The relative abundances of the light elements, H, C, N, and O, for several M and S stars were determined using the intensities of the infrared bands of H_2, H_2O, CN, CO, TiO, VO, and ZrO. Most of the M giant stars have a low O/C ratio which is difficult to explain. (auth)

23975 IDENTIFICATION PROBLEMS OF THE CARBON STARS IN THE SHORT WAVELENGTH REGION. Utsumi, K. (Tokyo Gakugei Univ.). pp 49-53 of Colloquium on Late-Type Stars. Trieste, Italy, Osservatorio Astronomico, 1966.

From Conference on Late-Type Stars, Trieste, Italy. See CONF-660665.

Measurements of wavelength and visual estimates of intensity of about 4000 lines between λ 4390 and λ 6900 and 2700 lines from λ 4396 to λ 6310 were made for the two carbon stars, U Hya and Y CVn, respectively, on the spectrograms with the dispersion of 5.4 ~ 8 Å/mm. In the region between about λ 4750 and λ 4850 the

effect of molecular absorptions is very small in most of the carbon stars. In U Hya, Sr I, Y I, Y II, Zr I, Ba II, Nd II, Sn II, and La II lines are strongly enhanced, while in Y CVn, Sr I, Y I, Y II, Zr I, and Ba II lines are not so strong but Nd II, Sm II, and La II lines appear strongly enhanced. The carbon stars which have relatively weak C_2 and CN bands seem to resemble S-type stars in their heavy metal abundances. (auth)

23976 THE $^{12}C/^{13}C$ ABUNDANCE RATIO IN THE COOL CARBON STARS, 19 PISCIUM, DS PEGASI, AND Y CANUM VENATICORUM. Climenhaga, J. L. (Univ. of Victoria, Can.). pp 54-74 of Colloquium on Late-Type Stars. Trieste, Italy, Osservatorio Astronomico, 1966.

From Conference on Late-Type Stars, Trieste, Italy. See CONF-660665.

Computations were made to obtain profiles in the spectral regions of the (4,0) CN band, the (2,0) CN band, and the (0,2) C_2 band, for conditions prevailing in the atmospheres of the carbon stars, and for different assumed values of the $^{12}C/^{13}C$ abundance ratio. These profiles were compared with tracings from high-dispersion (8 A/mm) spectrograms, obtained with the coudé spectrograph of the 48-inch telescope of the Dominion Astrophysical Observatory at Victoria, of the carbon stars 19 Piscium, DS Pegasi, and Y Canum Venaticorum. The abundance ratio $^{12}C/^{13}C$ was obtained (i) from a comparison of the depths of the observed and the calculated isotopic lines, and (ii) from the equivalent widths and the curve-of-growth of two selected groups of lines. The mean values found for the ratio were 3.8 for Y Canum Venaticorum, 7.5 for 19 Piscium, and 8.8 for DS Pegasi which are in agreement with earlier results and provide some evidence that the abundance ratio may vary for different stars from about 4/1 to higher values. (auth)

23977 ABUNDANCE RATIO OF ^{12}C TO ^{13}C IN SOME COOL CARBON STARS. Fujita, Y.; Tsuji, T.; Maehara, H. (Tokyo Univ.). pp 75-93 of Colloquium on Late-Type Stars. Trieste, Italy, Osservatorio Astronomico, 1966.

From Conference on Late-Type Stars, Trieste, Italy. See CONF-660665.

The carbon isotope ratio in thirteen cool carbon stars is discussed from an analysis of the rotational lines assigned to the CN Red System in the wavelength region of λλ 7900 to 8700 A. The central depths of the rotational lines of ^{12}CN, as well as those of ^{13}CN which are free from blendings and also not too badly disturbed by neighboring absorption, were measured. Then the curves-of-growth for ^{12}CN were constructed, the relative shift of which immediately gives the $^{12}C/^{13}C$ ratio. In this iso-intensities method, the saturation effect, which is quite serious in the spectra of cool carbon stars, is automatically taken into account on a purely empirical basis, and the resulting $^{12}C/^{13}C$ ratio is almost free from the present day uncertainties in the atmospheric structure of cool carbon stars. It was found that the $^{12}C/^{13}C$ ratio is highly sensitive to the excitation temperatures, which are difficult to determine. If the excitation temperatures are as high as the effective temperatures, the $^{12}C/^{13}C$ ratio is about 20 and this may be the minimum estimate of the $^{12}C/^{13}C$ ratio in the majority of cool carbon stars. If it is assumed that the excitation temperatures now available in the literature, the $^{12}C/^{13}C$ ratio may be 20 ~ 40 for the majority of cool carbon stars and, for some exceptional case such as Y CVn and RY Dra, the $^{12}C/^{13}C$ ratio may be 4 ~ 8. If the excitation temperatures are somewhat smaller than those which have been assumed, the $^{12}C/^{13}C$ ratios in a majority of cool carbon stars may approach the terrestrial value of 90. This possibility is quite likely, since the empirical pseudo curves-of-growth suggest rather low excitation temperatures, and also the tentatively assigned temperatures are by no means well established. At any rate, the $^{12}C/^{13}C$ ratios in cool carbon stars are somewhat larger than those found in the literature, in which the serious curve-of-growth effect was not properly taken into account. (auth)

23978 A NEW STUDY OF THE MK CLASSIFICATION OF BRIGHT M-TYPE STARS. Yamashita, Y. (Dominion Astrophysical Observatory, Victoria, Can.). pp 94-9 of Colloquium on Late-Type Stars. Trieste, Italy, Osservatorio Astronomico, 1966.

From Conference on Late-Type Stars, Trieste, Italy. See CONF-660665.

The luminosity criteria for M giants were studied on Victoria spectrograms of the MK standard stars and applied to some 150 bright stars. Spectral characteristics of several peculiar stars (M, S, and high-velocity stars) are discussed on the basis of the luminosity criteria, and results are given. (auth)

23979 IMAGE TUBE SPECTRA OF LATE-TYPE STARS. McCarthy, M. F. (Specola Vaticana, Castel Gandolfo, Vatican City State); Treanor, P. J.; Ford, W. Kent Jr. pp 100-8 of Colloquium on Late-Type Stars. Trieste, Italy, Osservatorio Astronomico, 1966.

From Conference on Late-Type Stars, Trieste, Italy. See CONF-660665.

Three sets of observations of the spectra of late-type stars were obtained as part of a program for testing cascaded image tubes and are discussed. Spectra with a dispersion of 360 A/mm were obtained with both the S 20 and S 1 primary cathodes; these spectra provide excellent means for classifying stars in the yellow, red, and and near infrared region; this dispersion is specially suitable for studies of spectra of the long period variables, for objects in which most of the radiation occurs in the infrared region, and for stars belonging to the faint end of the main sequences of open clusters. Spectra obtained at a dispersion of 48 A/mm reveal an abundance of lines and bands in the 1-μ region only a few of which have been identified with certainty. (auth)

23980 LUMINOSITY CRITERIA FOR FAINT LATE-TYPE STARS. Treanor, P. J.; McCarthy, M. F. (Specola Vaticana, Castel Gandolfo, Vatican City State). pp 109-15 of Colloquium on Late-Type Stars. Trieste, Italy, Osservatorio Astronomico, 1966.

From Conference on Late-Type Stars, Trieste, Italy. See CONF-660665.

Some current objective prism survey programs are reviewed with reference to the problems of luminosity classification of late-type stars which they involve. The luminosity characteristics of the sodium D lines and of the CaH bands near λ 6385 and λ 6880 A were studied using objective prism dispersions of 230 to 400 A/mm in the yellow red region. When examined with suitable filter-plate combinations, the D lines and the λ 6880 band prove to be satisfactory criteria over the range M0-M5, and can be used to about $m_{pg} = 14$ on objective prism plates, or to much fainter limits on image tube spectra of comparable dispersion. (auth)

23981 SPECTRAL CLASSIFICATION THROUGH NARROW-BAND PHOTOMETRY AND REDDENING DETERMINATION FOR THE M-TYPE GIANTS AND LONG-PERIOD VARIABLES. Smak, J. (Inst. of Astronomy, Warsaw). pp 116-20 of Colloquium on Late-Type Stars. Trieste, Italy, Osservatorio Astronomico, 1966.

From Conference on Late-Type Stars, Trieste, Italy. See CONF-660665.

The criteria used for classification of M-type giants and long-period variables through narrow-band photometry are described. The t index, intended to describe the strength of the λ 4955 band is defined as $t = [m(4900) + m(5100)/2] - m(5000)$, t is independent of the atmospheric and interstellar extinction. A new color index, b-V is introduced, because the U-B and B-V indices are affected by the emission lines of the Balmer series. The b magnitude is situated between 4400 and 5100 A. The results obtained so far indicate that the combined t, (b-V) photometry could provide information on spectral types and reddening of the long period variables. (auth)

23982 SOLAR ABUNDANCES OF SOME RARE EARTHS. Righini, A.; Rigutti, M. (Padua and Arcetri Observatories, Italy). pp 121-4 of Colloquium on Late-Type Stars. Trieste, Italy, Osservatorio Astronomico, 1966.

From Conference on Late-Type Stars, Trieste, Italy. See CONF-660665.

A brief report is given on research on solar abundances of seven 4f type rare earths. The weighting function method was adopted. Line identifications and equivalent widths came from Moore-Sitterly and, respectively, from the Utrecht Photometric Catalogue. Mutschlecner's photospheric semi-empirical model, Corliss and Bozman's gf values and partition functions were used. A comparison with meteoric abundances was made. (auth)

23983 ON THE SPECTRUM OF HR 774. Nishimura, S. (Tokyo Univ.). pp 125-9 of Colloquium on Late-Type Stars. Trieste, Italy, Osservatorio Astronomico, 1966.

From Conference on Late-Type Stars, Trieste, Italy. See CONF-660665.

A preliminary report of the curve-of-growth analysis of a barium star, HR 774, is presented. Sodium and aluminum are underabundant, and heavy elements are overabundant relative to ε Vir. (auth)

23984 SEARCH FOR AGEING EFFECTS IN THE COMPOSITION OF RED STARS OF THE GALACTIC HALO. Pagel, B. E. J. (Royal Greenwich Observatory, Eng.). pp 133-45 of Colloquium on Late-Type Stars. Trieste, Italy, Osservatorio Astronomico, 1966.

From Conference on Late-Type Stars, Trieste, Italy. See CONF-660665.

Complications in the application of the differential curve-of-growth method to cool stars with weak spectral lines are described. The halo red giants Barnard III-13 in M 92 and HDE 232078, previously studied by Helfer, Wallerstein, and Greenstein (1959), are

rediscussed in the light of these complications and the results are presented together with those of a new analysis of the cool subdwarf HD 25329. These data are combined with results previously derived for the halo red giant HD 122563 so as to study the behavior of the abundances of individual elements as a function of iron: hydrogen ratio and to draw some general qualitative conclusions on element-formation in the early history of the Galaxy. (auth)

23985 VARIATIONS OF THE H AND K EMISSIONS OF THE M DWARF HD 119850. Kandel, R. (Observatoire de Paris, Meudon, France). pp 146-7 of Colloquium on Late-Type Stars. Trieste, Italy, Osservatorio Astronomico, 1966.

From Conference on Late-Type Stars, Trieste, Italy. See CONF-660665.

Spectrum observations between 1961 and 1965 indicate a drop in the intensity of the Ca II H and K emission components in 1962, followed by recovery to the previous level. (auth)

23986 PRELIMINARY RESULTS ON THE SPECTRUM OF 61 CYG B. Kandel, R. (Observatoire de Paris, Meudon, France). pp 148-9 of Colloquium on Late-Type Stars. Trieste, Italy, Osservatorio Astronomico, 1966.

From Conference on Late-Type Stars, Trieste, Italy. See CONF-660665.

Curves of growth were produced for several elements, and the microturbulence was derived from spectra of 61 Cyg B. (auth)

23987 DETAILED ANALYSIS OF SEVEN K STARS. Cayrel, G. (Institut d'Astrophysique, Paris). pp 150-2 of Colloquium on Late-Type Stars. Trieste, Italy, Osservatorio Astronomico, 1966.

From Conference on Late-Type Stars, Trieste, Italy. See CONF-660665.

A detailed analysis of two main-sequence K stars and five K giants was made. The spectroscopic particularities of these stars were interpreted in terms of gravity, effective temperature, atmospheric microturbulence, and chemical composition. The high-velocity giant HD 6833 has a strong deficiency of sodium. (auth)

23988 OBSERVATIONS OF THE SPECTRUM OF VV CEPHEI OBTAINED DURING AND AFTER THE 1956-57 ECLIPSE. Wright, K. O. (Dominion Astrophysical Observatory, Victoria, Can.). pp 153-8 of Colloquium on Late-Type Stars. Trieste, Italy, Osservatorio Astronomico, 1966.

From Conference on Late-Type Stars, Trieste, Italy. See CONF-660665.

The Victoria high-dispersion spectrograms of VV Cephei obtained between 1956 and 1966 are discussed. These include observations made in the ultraviolet, photographic, and visual (especially Hα) regions of the spectrum. Radial velocity measurements agree quite well with Peery's recent orbit. Preliminary measurements of chromospheric line intensities were made but the analysis depends on revised values of the ratio of the continua of the B- and M-type stars. Large changes in the structure of the emission H_α lines were observed. Numerous emission lines in the far ultraviolet region were measured. (auth)

23989 SPECTROSCOPIC OBSERVATIONS OF SOME VARIABLES OF SPECTRAL TYPE Se NEAR PHASE OF MAXIMUM LIGHT. Bretz, M. C. (Observatoire, Marseille). pp 166-73 of Colloquium on Late-Type Stars. Trieste, Italy, Osservatorio Astronomico, 1966.

From Conference on Late-Type Stars, Trieste, Italy. See CONF-660665.

The Hα emission line profile in Se-type long period variables near maximum phase is observed to be mutilated by absorption, the strongest minimum lying at λ 6563.0 A, with a strong emission feature of about 1.3 A total width at shorter wavelengths and a fainter one on the longward side. Their centers are separated by 1.2 A. The half-distance point between the two emissions lies very close to the laboratory position of Hα, (at λ_0 of 0.05 A in the 1962 spectrogram of T Cam). Difficulties of precise wavelength determinations in spectra of long period variables are pointed out. Identification of the principal absorption feature within the Hα emission with metallic lines or band lines of metallic oxides has not been possible. From a comparison of the mutilated Hα profile at maximum light in Se variables with that of Mira at about the same phase, it appears likely that another molecule besides TiO, one, present in the atmospheres of both types of long-period variables may, at least partly, be responsible for the absorption observed in the Hα emission profile. On several spectrograms of χ Cygni obtained shortly after its maximum in May 1966 the resonance lines of potassium in the near infrared and of sodium in May 1966 the resonance lines of potassium in the near infrared and of sodium (D-lines) are present in emission. In spectrograms of long-period variables taken at this phase of the cycle, they had, up till now, always been observed as pure absorption lines. (auth)

23990 EFFECT OF TEMPERATURE AND BLANKETING IN O. C. WILSON K3 STARS AND K0 AND K1 STARS OF HYADES. Rousseau, J. (Observatoire, Lyon). pp 174-9 of Colloquium on Late-Type Stars. Trieste, Italy, Osservatorio Astronomico, 1966. (In French).

From Conference on Late-Type Stars, Trieste, Italy. See CONF-660665.

The (P-V) dispersion observed in the case of K3 stars of O. C. Wilson (1962) proceeds from two effects: a real effect of temperature and a blanketing effect, probably coming from microturbulence. The blanketing effect appears also in the case of the K0 and K1 stars of the Hyades. (tr-auth)

23991 PRELIMINARY RESULTS OF THE STUDY OF THE POPULATION II CEPHEID RU CAMELOPARDALIS. Faraggiana, R.; Hack, M. (Astronomical Observatory, Trieste, Italy). pp 180-5 of Colloquium on Late-Type Stars. Trieste, Italy, Osservatorio Astronomico, 1966

From Conference on Late-Type Stars, Trieste, Italy. See CONF-660665.

The results of the study of eleven high-dispersion spectrograms of RU Cam are given. The radial velocity curve presents stratification effects. (auth)

23992 THE SECOND INFRARED FLIGHT OF STRATOSCOPE II. Danielson, R. E. (Princeton Univ. Observatory, N. J.). pp 186-204 of Colloquium on Late-Type Stars. Trieste, Italy, Osservatorio Astronomico, 1966.

From Conference on Late-Type Stars, Trieste, Italy. See CONF-660665.

The infrared mode of the Stratoscope II instrument and the balloon launching technique are reviewed. The pre-flight testing and the flight operations are briefly described as they occurred in the second flight. Some typical infrared spectra are shown. (auth)

23993 MAGNITUDES AT 1.04 MICRONS. Wing, R. F. (Univ. of California, Berkeley). pp 205-14 of Colloquium on Late-Type Stars. Trieste, Italy, Osservatorio Astronomico, 1966.

From Conference on Late-Type Stars, Trieste, Italy. See CONF-660665.

Stellar magnitudes are being measured photoelectrically with a 30-Å band pass centered at 1.04 μ; these are particularly useful for studies of late-type stars since they are free from serious blanketing. The magnitude system is defined by the values for thirty standard stars. The limitations on the width of the band pass that can be used for different spectral types are discussed. The magnitudes at 1.04 μ are compared to the visual magnitudes and to wide-band infrared magnitudes that are used on other systems. The light curve of the Mira-type variable χ Cygni at 1.04 μ shows a phase lag, relative to the visual light curve, similar to that previously found in the radiometric curve. The possibility is considered of measuring faint stars at approximately the same effective wavelength by means of photographic photometry with the type Z emulsion. (auth)

23994 OPACITY OF HOT WATER VAPOR. Auman, J. R. Jr. (Princeton Univ. Observatory, N. J.). pp 215-24 of Colloquium on Late-Type Stars. Trieste, Italy, Osservatorio Astronomico, 1966.

From Conference on Late-Type Stars, Trieste, Italy. See CONF-660665.

As a step in the analysis of the infrared observations of late-type stars made by Stratoscope II, the opacity due to water vapor was calculated in the spectral region between 0.8 μ and 12.5 μ in the temperature range, θ = 1.5, 2.0, 2.5, and 3.0 for rms turbulent velocities of 2, 4, and 8 km/sec. The strengths and positions of the individual spectral lines were calculated, and the contributions of individual lines were combined to compute the opacity. The opacity due to water vapor was found to be important for θ = 1.5 and to be dominant for $\theta \geq 2.0$. (auth)

23995 INFRARED PHOTOMETRY OF LATE-TYPE STARS. Bahng, J. (Dearborn Observatory, Evanston, Ill. Kitt Peak National Observatory, Tucson, Ariz.). pp 225-30 of Colloquium on Late-Type Stars. Trieste, Italy, Osservatorio Astronomico, 1966.

From Conference on Late-Type Stars, Trieste, Italy. See CONF-660665.

Three-color observations of late-type stars in the infrared at 1.2, 1.6, and 2.2 μ are presented. The infrared colors show that G, K, and M stars have a continuous energy distribution deviating considerably from that of a black body in this spectral region. The deviation may be explained as a result of excess continuum emission near 1.6 μ due to the H^- opacity window in the atmospheres of these stars. The infrared colors of carbon stars show a poor correlation with the Morgan-Keenan temperature class. Either the

molecular absorption features in the spectra affect the colors very strongly, or some mechanism of continuous opacity such as the one proposed by Hoyle and Wickramasinghe redistributes the radiation from the photosphere. Whatever the mechanism, the carbon stars appear to radiate more nearly as black bodies than do the M stars. (auth)

23996 INFRARED SCANNER MEASUREMENTS OF THE COLORS AND MOLECULAR BAND STRENGTHS OF LATE-TYPE STARS. Wing, R. F. (Univ. of California, Berkeley). pp 231-41 of Colloquium on Late-Type Stars. Trieste, Italy, Osservatorio Astronomico, 1966.

From Conference on Late-Type Stars, Trieste, Italy. See CONF-660665.

An investigation of late-type stars by means of narrow-band photoelectric photometry is being conducted at Lick Observatory. The program includes cool stars of all spectral types and variable stars of several kinds, and many Mira variables are being observed throughout their cycles. Each star is measured at 26 wavelengths in the 1 μ spectral region, and indices of the temperature and the band strengths of the molecules CN, TiO, VO, H_2O, and ZrO are formed. Spectra of stars representing ten spectral types are shown, and the methods for detecting differences in chemical composition are briefly discussed. (auth)

23997 SOURCES OF OPACITY IN LATE-TYPE STARS: A REVIEW. Vardya, M. S. (Sterrewacht Sonnenborgh, Utrecht). pp 242-9 of Colloquium on Late-Type Stars. Trieste, Italy, Osservatorio Astronomico, 1966.

From Conference on Late-Type Stars, Trieste, Italy. See CONF-660665.

Various opacity sources, which may possibly play some role in the outer layers of late-type stars, were reviewed. The opacity sources considered include a host of negative ions and neutral atoms contributing to continuous absorption, atoms and molecules contributing to Rayleigh scattering, molecules acting as blanketing agents, and translational absorption. (auth)

23998 SUPERSATURATION OF CARBON VAPOUR IN THE CARBON STARS. Kamijo, F. (Univ., Goettingen, Ger.). pp 252-9 of Colloquium on Late-Type Stars. Trieste, Italy, Osservatorio Astronomico, 1966.

From Conference on Late-Type Stars, Trieste, Italy. See CONF-660665.

The formation of graphite particles in the atmosphere of C-type Mira variable stars is calculated theoretically by the use of the V.W.B.D. theory. The result shows that the nucleation takes place fast enough to follow the temperature variation of the variable and to remove the supersaturation to vapor pressure. (auth)

23999 MODEL ATMOSPHERE APPROACH IN LATE-TYPE STARS. Tsuji, T. (Tokyo Univ.). pp 260-90 of Colloquium on Late-Type Stars. Trieste, Italy, Osservatorio Astronomico, 1966.

From Conference on Late-Type Stars, Trieste, Italy. See CONF-660665.

The atmospheres of M-supergiant and M-dwarf stars are investigated by the model atmosphere method. In the construction of model atmospheres, the constancy of the total flux is achieved in sufficient accuracy by means of the iterative temperature correction procedure. The molecular line opacity due to vibration–rotation bands as well as pure rotation bands of H_2O, CO, and OH is taken into account in addition to the sources of continuous opacity such as H^- bf + ff, H_2^- ff, H bf + ff, Rayleigh scattering of H as well as H_2, and electron scattering. For the M-supergiant stars with T_e = 3000°K, log g = 1.0, and solar chemical composition, the radiative equilibrium models with and without molecular line opacity are constructed. The blanketing effect of H_2O and CO bands is shown to be of essential importance not only on the emergent radiation flux but also on the temperature structure. The constant flux model in which the molecular line opacity is taken into account is characterized by a low surface temperature ($T_0 \sim 1300$°K) and a rather rapid temperature rise inward while constant flux model in which the line opacity is disregarded shows rather high surface temperature ($T_0 \sim 2400$°K) and a moderate temperature rise inward. It turns out from the examination of the recent infrared observations of red giant stars that the theoretical flux calculated from the radiative equilibrium model including molecular line opacity shows reasonable agreement with the observed ones. In M-dwarf model with T_e = 3000°K, log g = 4.8, and solar composition mixture, which may roughly correspond to M6 dwarfs, the molecular line absorptions have a similar effect as in M-supergiant stars. From the comparison with the available observational data, it appears that the effective temperature of M6V star is around 3000°K. (auth)

24000 MODEL ATMOSPHERES FOR LATE-TYPE STARS. Gingerich, O. (Smithsonian Astrophysical Observatory, Cambridge, Mass. Harvard Univ., Cambridge, Mass.); Latham, D. W.; Linsky, J.; Kumar, S. S. pp 291-312 of Colloquium on Late-Type Stars. Trieste, Italy, Osservatorio Astronomico, 1966.

From Conference on Late-Type Stars, Trieste, Italy. See CONF-660665.

Five model atmospheres for T_{eff} = 2500°K with gravities ranging from dwarf to supergiant are presented in detail; they are among the most nongray models ever computed. Particular attention was paid to the equation of state for the atomic electron contributers and to the treatment of scattering, which is a major opacity source. These radiative equilibrium models are idealized in that one does not include water-vapor absorption or convection, but it is indicated how these models may differ from more realistic cases. In all of the models molecular hydrogen predominates, and in the dwarf models the photospheric gas pressure exceed several hundred Earth atmospheres. Models with low-metal abundances appear to mimic normal models with higher gravities. (auth)

24001 MODEL ATMOSPHERES FOR LATE-TYPE STARS. Auman, J. R. Jr. (Princeton Univ. Observatory, N. J.). pp 313-18 of Colloquium on Late-Type Stars. Trieste, Italy, Osservatorio Astronomico, 1966.

From Conference on Late-Type Stars, Trieste, Italy. See CONF-660665.

In order to check the effect of the opacity due to water vapor on the structure of model atmospheres of late-type stars, the model atmosphere of a star with the effective temperature of 2520°K and with log g = 3.0 was calculated with and without the opacity due to water vapor. The inclusion of the opacity due to water vapor decreases the pressure in the atmosphere and lowers the surface temperature. The model atmosphere is compared with the observed flux from Rho Persei and Mu Geminorum obtained from observations by Stratoscope II. These stars would seem to have a lower value of the O/C ratio than the value of 1.7. (auth)

24002 STELLAR EVOLUTION AND LATE-TYPE STARS. Kippenhahn, R. (Goettingen Univ. Observatory, Ger.). pp 319-40 of Colloquium on Late-Type Stars. Trieste, Italy, Osservatorio Astronomico, 1966.

From Conference on Late-Type Stars, Trieste, Italy. See CONF-660665.

A brief outline of stellar evolution is given, with particular concern to the region of the HR diagram where late-type stars are placed. This region is the place where the collapsing interstellar cloud settles down in hydrostatic equilibrium and the star becomes identifiable as such. And it is also the region where in advanced evolutionary phases we loose track of the star's path in the HR diagram. The evolution of an artificial stellar cluster, composed of 190 stars, the masses of which are distributed according to the luminosity function adopted by Sandage, is followed from age zero to age 4.24×10^9 years, and the results are compared with the observations. When the stars move back into the late-type star region after the main sequence phase, it is important to follow the evolution of the interior where the heavy elements are formed. This evolution is followed for a star of 7 solar masses, 5 solar masses (population I), and 1.3 solar masses (population II). (auth)

24003 PLANETARY COMPANIONS AS LATE-TYPE STARS. Kumar, S. S. (Univ. of Virginia, Charlottesville). pp 341-6 of Colloquium on Late-Type Stars. Trieste, Italy, Osservatorio Astronomico, 1966.

From Conference on Late-Type Stars, Trieste, Italy. See CONF-660665.

The evolution of stars of low mass is discussed and it is shown that the end product of the evolution is a red, intrinsically faint star. From the data on mass ratios and eccentricities in the visual binaries containing M dwarfs, it is shown that the known planetary companions can be identified with dead stars of very low mass. (auth)

24004 MODELS FOR WHOLLY CONVECTIVE RED DWARFS AND THEIR VIBRATIONAL STABILITY. Gabriel, M. (Univ., Liege). pp 347-56 of Colloquium on Late-Type Stars. Trieste, Italy, Osservatorio Astronomico, 1966.

From Conference on Late-Type Stars, Trieste, Italy. See CONF-660665.

Models were computed for Kr60A (0.27 $M_\odot$) and for Kr60B (0.16 $M_\odot$). Both are found to be wholly convective except for a thin atmosphere in radiative equilibrium. The vibrational stability of the models is then examined. They are both unstable with e-folding times $\tau = |\sigma'|^{-1}$ short relative to their life time. (auth)

24005 EARLY CONTRACTION PHASES OF THE STARS. Ezer, D. (Goddard Space Flight Center, New York). pp 357-67 of Colloquium on Late-Type Stars. Trieste, Italy, Osservatorio Astronomico, 1966.

From Conference on Late-Type Stars, Trieste, Italy. See CONF-660665.

The evolution of the stars in the mass range 0.1 M⊙ to 100 M⊙ with a composition X = 0.739, Z = 0.021, was studied in their gravitational contraction stages. In each case, the evolutionary study starts at the point when the star becomes stable against gravitational collapse from energy considerations, and the effect of mass loss during the gravitational contraction phase was neglected. The ratio of the mixing-length to the pressure scale height is taken as equal to two in the treatment of the convection because this gives an approximate fit to the present properties of the Sun. In each case, the general behavior of the evolutionary track in the Hertzsprung–Russell diagram is the same; there is an almost vertical path corresponding to the evolution in the fully convective gravitationally contracting phase and the path becomes shorter as the mass of the star increases. The time the star of 100 M⊙ spends during the fully convective phase is only of the order of a few tens of years, but the 0.2 M⊙ star reaches the main sequence as a wholly convective star in 1.7×10^3 years. During the evolution of 0.1 M⊙ star the maximum central temperature attained is 4×10^6°K which is not sufficient to stabilize the star on the hydrogen-burning main sequence, therefore, as contraction continues the star contracts towards the white dwarf configuration. Theoretical equal time lines in the Hertzsprung–Russell diagram are obtained as a result of the theoretical evolutionary study of early contraction phases of the stars in a wide range of stellar masses. The observational results of very young cluster NGC 2264 which contains T Tauri stars, believed to be in the gravitational contraction phase, are compared with the theoretical study. (auth)

24006 A COMPARISON OF THEORETICAL AND OBSERVED EVOLUTIONARY PATHS IN THE RED GIANT REGION OF THE H. R. DIAGRAM. Barbaro, G.; Dallaporta, N.; Nobili, L. (Univ., Padua). pp 368–87 of Colloquium on Late-Type Stars. Trieste, Italy, Osservatorio Astronomico, 1966.

From Conference on Late-Type Stars, Trieste, Italy. See CONF-660665.

The H–R diagrams of 38 open clusters and dynamical groups of stars of early and late population I are compared with the theoretical evolutionary tracks of given mass available up to now; in order to determine by this mean the masses and ages of evolved stars of different types. From the analysis of the collected material the following points result: (a) Cepheids, as expected, appear to be located on a well defined sequence with masses between 4 and 7 M⊙; (b) the existence of a horizontal branch for the older (low mass) galactic clusters and groups, which is probably related, according to present evolutionary theories, to the ignition of the He-flash, allows to deduce an upper mass limit (probably around 1.5 M⊙) for the occurrence of this phenomenon; (c) C and S stars are found to be evolved members of low mass, and therefore old, clusters, in contrast with the observed trend of part at least of these stars, to concentrate along spiral arms; this fact suggests the possible existence of two kinds of such objects of different mass range and age; (d) except for a well known group of young supergiant small amplitude red variables of the h and χ Persei type, the semiregular, irregular and long period (one case) variables are found on a well defined sequence following the right border up to the top of the giant branch of the clusters and groups, indicating for all these stars a probable mass value not much higher than solar mass. (auth)

24007 EVOLUTION OF A 5-SOLAR MASS STAR AFTER CENTRAL HELIUM BURNING. Weigert, A. (Univ., Goettingen, Ger.). pp 388–94 of Colloquium on Late-Type Stars. Trieste, Italy, Osservatorio Astronomico, 1966.

From Conference on Late-Type Stars, Trieste, Italy. See CONF-660665.

The evolutionary phase of core contraction after central helium burning is recalculated, taking into account energy losses due to photoneutrinos and plasmaneutrinos. These energy losses cause a decrease of the temperature in the degenerated central region of the star. Therefore, the neutrino luminosity remains small and the carbon flash is avoided. The helium burning shell source in these models becomes thermally unstable. The resulting thermal runaway is repeated in time intervals of some 10^3 years. (auth)

24008 INFLUENCE OF NEUTRINO PROCESSES ON THE HELIUMFLASH. Thomas, H. C. (Max-Planck-Institut fuer Physik und Astrophysik, Munich). pp 395–7 of Colloquium on Late-Type Stars. Trieste, Italy, Osservatorio Astronomico, 1966.

From Conference on Late-Type Stars, Trieste, Italy. See CONF-660665.

The evolution of a star of 1.3 M⊙ was calculated from hydrogen burning on the main sequence up to the ignition of helium and through the phase of the helium flash. Weak interaction neutrino processes were taken into account. (auth)

24009 STATISTICS OF LATE-TYPE STARS. Iwanowska, W. (Copernicus Univ., Torun, Poland). pp 393–404 of Colloquium on Late-Type Stars. Trieste, Italy, Osservatorio Astronomico, 1966.

From Conference on Late-Type Stars, Trieste, Italy. See CONF-660665.

A review of the present knowledge on the number, spatial distribution and kinematical properties of late-type stars is given with a presentation of some of these data with the aid of two-term frequency-functions. (auth)

24010 THE M SUPERGIANTS OF h AND χ PERSEI. Wildey, R. L. (Geological Survey, Flagstaff, Ariz.). pp 405–15 of Colloquium on Late-Type Stars. Trieste, Italy, Osservatorio Astronomico, 1966.

From Conference on Late-Type Stars, Trieste, Italy. See CONF-660665.

Theoretical nuclear astrophysics is examined for its prediction of the appearance of the color–magnitude diagram of the young galactic cluster and association, h and χ Persei. The more traditional theory of nucleonic interactions is in excellent agreement with the observations. However, order-of-magnitude discrepancies exist for the prediction, by the conserved vector-current theory of weak-coupling interactions, of the ratio of late to early supergiants. The errors in the observational reduction stages appear entirely too small for the color–magnitude sequences to be fortuitously placed in agreement with prediction. Theoretical mechanisms for avoiding the high interior temperatures at which the neutrino–neutrino processes occur seem inadequate. The cross-correlation function of celestial sphere angular distributions of early and late supergiants appears to agree too well with the autocorrelation of the M supergiants, themselves, for one to submit to the hypothesis that the early and late supergiants do not belong to the same hierarchy of star formation. Finally, a color photographic survey of this region of sky indicates that the established ratio of late to early supergiants cannot be rendered sufficiently erroneous by considerations of completeness. (auth)

24011 KINEMATICS OF THE MIRA-TYPE VARIABLES. Smak, J. (Inst. of Astronomy, Warsaw). pp 416–19 of Colloquium on Late-Type Stars. Trieste, Italy, Osservatorio Astronomico, 1966.

From Conference on Late-Type Stars, Trieste, Italy. See CONF-660665.

The aim of the present review is to summarize the results obtained in the past and to discuss the possibilities and limitations of the future research concerning the kinematics of the Mira-type variables. (auth)

24012 THE DISTRIBUTION OF THE M-, S-, AND C-TYPE STARS IN THE MILKY WAY. Mavridis, L. N. (Univ. of Thessaloniki, Greece). pp 420–46 of Colloquium on Late-Type Stars. Trieste, Italy, Osservatorio Astronomico, 1966.

From Conference on Late-Type Stars, Trieste, Italy. See CONF-660665.

The study of the structure of the Galaxy is carried out by examining the distribution of the stars of a given spectral type and luminosity class in galactic longitude and latitude as well as with heliocentric distance. This is done with the help of objective prism spectra to determine spectral and luminosity classification, and photoelectric observations for magnitudes and colors; then a study is made of the surface distribution and of the space distribution. This was done first using O and B stars and later from studies of the red star distribution using infrared techniques (objective prism low dispersion infrared spectra) which has several advantages as follows: (1) Interstellar absorption in the infrared is one half the visual absorption. (2) The C, S, and nearly all M stars are giants and easily recognizable, and the M stars are numerous for good statistical analysis. The criteria used for the spectral classification of the M- C- and S-type stars are exposed. The Galactic Belt Surveys of Nassau, of Blanco and L. Münch, of E. V. P. Smith and H. J. Smith, of Westerlund are discussed as well as the surveys in Selected Regions by these and other investigators like Albers, McCuskey, and Mehlhorn, Mavridis. It is evident that much work has already been done in the study of the intrinsic properties and the space distribution of M, C, and S stars in the Galaxy, but much more must be done with the photometry of these stars. It is necessary to establish accurate photoelectric sequences distributed over the sky in photometric systems containing also magnitudes corresponding to the red and the infrared region of the spectrum, and therefore a better determination of the absolute magnitudes, intrinsic colors, and interstellar reddening of these stars. (auth)

24013 THE USE OF EARLY M-TYPE STARS FOR DETERMINING INTERSTELLAR ABSORPTION. Neckel, H. (Hamburg-Observatory, Ger.). pp 447-52 of Colloquium on Late-Type Stars. Trieste, Italy, Osservatorio Astronomico, 1966.

From Conference on Late-Type Stars, Trieste, Italy. See CONF-660665.

It is shown that the early-M-type stars are the most suitable objects for determining interstellar absorption by observations of the colors V and N (where N is Johnson's color at 10 micron). (auth)

24014 STATISTICAL POPULATION INDICES OF CLASS M LONG PERIOD VARIABLES. Iwanowska, W.; Maron, N. (Copernicus Univ., Torun, Poland). pp 453-7 of Colloquium on Late-Type Stars. Trieste, Italy, Osservatorio Astronomico, 1966.

From Conference on Late-Type Stars, Trieste, Italy. See CONF-660665.

Using a two-term frequency-function of coordinates and velocities, statistical population indices (the logarithms of the ratio of statistical probabilities of a star's belonging to one or another component) were calculated for 380 Mira-type variables. A clear-cut division into two population components is obtained. The well known relation between the length of the period and the population type is shown to be principally a result of distance selection effects. (auth)

24015 QUALITATIVE CONSIDERATIONS ON NEUTRINO-EMISSION EFFECTS DURING THE RED GIANT STAGE. Dallaporta, N.; Sussi Veronese, M. G. (Univ., Padua). pp 458-65 of Colloquium on Late-Type Stars. Trieste, Italy, Osservatorio Astronomico, 1966.

From Conference on Late-Type Stars, Trieste, Italy. See CONF-660665.

According to a simplified model, some effects of radiation pressure on the core of evolved giants when the neutrino losses are effective were considered. The suggestions are that the carbon flash could be a much rarer occurrence in stellar evolution than was hitherto surmised; and that the radiation pressure could operate in order to counterbalance the degeneracy and help the star to effectively reach high central temperature states. (auth)

24016 THEORETICAL MODELS OF NOVAE. Sparks, Warren Morgan. Bloomington, Ind., Indiana Univ., 1967. 186p.

Thesis.

General observations of novae as well as observations of individual novae are presented. The theories which have been proposed to explain these observations are reviewed. The theoretical formulation used in this investigation is developed, and a computer code based on this formulation is employed. The theoretical velocity of a shock wave is derived and compared with calculations from the computer code. The present investigation is a study of the effects of a sudden injection of internal energy into an envelope that is radiative and in hydrodynamic equilibrium. The time variation of the pressure, temperature, density, position, and other physical quantities is determined at many fixed mass points. The emergent luminosity and the "velocity of the photosphere" are then known as functions of time. These quantities are compared with observations of novae. (The "velocity of the photosphere" is compared with the velocity of the absorption spectrum in a qualitative way, which is justifiable.) It is found that there are two types of ejections which can give rise to novae. The "flash" nova, e.g., T. Coronae Borealis, has a very fast rising and falling light curve and a rapidly decreasing velocity curve. It is found that a shock wave which imparts a velocity which is greater than the escape velocity to the outer layers of the star will produce this behavior. A less rapid rising and falling light curve and a nearly constant velocity are characteristic of the "ordinary" nova, e.g., GK Persei. These features will result when the stellar material is forced outward from the star by the increase of pressure in the region where the internal energy is injected. The pre-maximum halt, which is characteristic of this latter type of nova, results from the temperature dependence of the opacity of neutral hydrogen. (Diss. Abstr.)

24017 THE EFFECT OF PHOTOSPHERIC INHOMOGENEITIES ON THE EMERGENT RADIATION FIELD OF THE SUN. Margrave, Thomas Ewing Jr. Tucson, Ariz., Univ. of Arizona, 1967. 179p.

Thesis.

The existence of solar granulation is indicative of horizontal variations of the physical conditions in the photosphere. The main purpose of this dissertation is to take account of this inhomogeneous structure in constructing a nongray blanketed model photosphere which is in radiative equilibrium throughout its upper layers. The goal is to achieve better agreement between the predicted and observed emergent continuum radiation fields of the Sun than has been exhibited by previous theoretical model photospheres. The procedure followed in the construction of a homogeneous nongray blanketed model photosphere in radiative equilibrium is thoroughly discussed. The details of calculating the radiation field are also outlined. The necessary data and formulae for carrying out such calculations are given, since the same basic technique is used for the inhomogeneous models. The model fits the observed central continuum intensities of the Sun to within 5% for 5000 A $\leq \lambda \geq$ 10,000 A and agrees with the observed solar continuum limb darkening to a general accuracy of 0.2% at $\mu = 0.85$, 0.5% at $\mu = 0.50$, and 0.8% at $\mu = 0.30$ over the spectral range 4000 A $\leq \lambda \leq$ 10,000 A. The final model has a blanketing coefficient of approximately 0.16 and an rms relative continuum intensity fluctuation of ± 0.15 at a wavelength of 5000 A. Although these values are somewhat high, they are not considered unacceptable because of the large spread in the published values. (Diss. Abstr.)

24018 SUPER-ALFVENIC ALIGNED-FIELD AIRFOILS OR THE FLOW OF THE SOLAR WIND PAST AN ANGEL'S WING. Yannitell, Daniel William. Ithaca, N. Y., Cornell Univ., 1967. 105p.

Thesis.

The major problem treated is that of hydromagnetic flow past a thin symmetric airfoil, impulsively set into motion along a uniform applied magnetic field at a speed greater than that of Alfvén waves. Before this problem is solved, however, a general discussion of the characteristics and boundary conditions in MHD flows is given. It is shown that large disturbances are created initially through the emission of Alfvén waves, and that these disturbances are confined to wave clusters whose thickness is small, of the same order as the airfoil thickness. Alfvén emission persists for a finite time only, after which these clusters are shed downstream, leaving essentially ordinary potential flow in the neighborhood of the airfoil. This is contrasted with sub-Alfvénic flow where the wave emission continues, the clusters remaining attached to the airfoil and ultimately forming slug regions fore and aft in which the fluid is brought to rest relative to the airfoil. The accelerating airfoil is also discussed to justify the consideration of impulsive starts. Other related problems treated include the effects of arbitrary magnetic Prandtl number, and of airfoil conductivity as well as the axially symmetric slender body. (Disser. Abstr.)

24019 SPEKTROSKOPIYA VAKUUMNOGO UL'TRAFIOLETA. (Vacuum Ultraviolet Spectroscopy). Zaidel', A. N.; Shreider, E. Ya. Fizika i Tekhnika Spektral'nogo Analiza (Biblioteka Inzhenera). Moscow, Izdatel'stvo Nauka Glavnaya Redaktsiya Fiziko-Matematicheskoi Literatury, 1967. 472p.

Basic experimental methods for vacuum spectroscopy in cosmic studies and hot plasma physics are described. The sources of radiation, their properties, continuum and multilinear spectra, Lyman continuum, and hot plasma installations are discussed in the first chapter. The second and third chapters describe the optical materials and spectral devices including convex diffraction lattices, devices for rocket studies, and interference and polarization devices. Vacuum ultraviolet recording receivers, wave measurement methods, and energy measurements in the vacuum ultraviolet are covered in the fifth and sixth chapters. Absorption spectra in vacuum regions, determination of atomic constants, plasma studies, shortwave solar radiation and application of the vacuum region for spectral analysis are discussed in the last five chapters. Extension references are given at the end of each chapter. (R.V.J.)

24020 SOLAR LOOP PROMINENCES: A THEORETICAL MODEL. Olson, Carl Adelbert. Lafayette, Ind., Purdue Univ., 1967. 54p.

Thesis.

A theoretical model of the loop prominence–flare event is given, in which the compression by the magnetic fields which may cause the solar flare is also made to cause the loop prominence. This model is based on the condensation theory of prominences in which a plasma compressed by a magnetic field loses heat by conduction and radiation. The model is used to get time–height graphs of the loop prominence–flare event which show good agreement with observations up to altitudes of about 30,000 km. This is done for compression times of 500 to 1000 sec. The family of curves in the time–height graphs are obtained by varying the initial temperatures. It is shown that the way in which the final density was reached during the compression, or using various types of compression, did not significantly affect the results. Condensation theories have been criticized in the past due to the difficulties of supplying sufficient mass. It is shown in the present model that sufficient mass for the region in which the model is valid can be supplied from the coronal condensation. Since the model in ques-

tion seems to be valid only for the lower loops of the loop prominence system, it is suggested that the fast particle theory of loop prominences might be valid in the higher regions. (Disser. Abstr.)

24021 SPECTRAL LINE FORMATION. Jefferies, John T. A Blaisdell Book in the Pure and Applied Sciences. Waltham, Mass., Blaisdell Publishing Co., 1968. 315p. $10.50.

Written for advanced courses in stellar atmospheres or general astrophysics, this text should also prove useful to research workers in astrophysics and plasma diagnostics. A comprehensive treatment of the non-LTE theory of spectral line formation is presented. The theory for the interpretation of the line radiation emitted by low-density atmospheres, such as the surface layers of the Sun, or low-pressure laboratory discharges, is developed. The "rate process" point of view is applied to the excitation of radiation in a gas and its transfer through the atmosphere. The synthetic problem of computing the radiation emerging from a gas in a specific state is studied and the emergent spectrum is analyzed in order to determine the state of the gas. Development of the generalized, or non-LTE, theory of line formation and analysis is achieved. (W.D.M.)

24022 PLANETS, STARS, AND GALAXIES. AN INTRODUCTION TO ASTRONOMY. SECOND EDITION. Inglis, Stuart J. New York, John Wiley and Sons, Inc., 1967. 487p. $7.95.

The book stresses three main features of astronomy: first, the methods of observing astronomical objects, using all regions of the electromagnetic spectrum; second, the interpretation of these observations (with the necessary physics); and third, ideas of the evolutionary processes in stars and galaxies. In addition, the last chapter stresses speculations of space, time, and the Universe. (W.D.M.)

Atomic and Molecular Physics

Refer also to abstracts 23707, 23972, 24163, 24436, 24454, 24634, 24785, 24822, 24823, and 24887.

24023 (CONF-670502-, pp 101-11) M SERIES X-RAY EMISSION LINES OF THE RARE EARTHS. Burr, A. F. (New Mexico State Univ., University Park).

A review of the wavelengths and energy levels assigned to the M series x-ray transitions of the rare earths shows that the width and pronounced structure of the Mα line has made the determination of its wavelength difficult and has introduced some uncertainty in the value to be given to the N(VI,VII) energy level. A program of selecting the most probable values for energy levels and wavelengths of x-ray lines was extended by using modified Moseley diagrams to include the information contained in adjacent elements. Revised Mα and Mβ wavelengths are given for a number of rare earths as well as revised N(VI, VII) energy levels. Further information is given on the origin of the structure of the Mα line in the rare earth region of the periodic table. (auth)

24024 (CONF-670502-, pp 487-94) POSITRON ANNIHILATION IN RARE EARTH SINGLE CRYSTALS. Williams, R. W. (Iowa State Univ. of Science and Technology, Ames); Mackintosh, A. R. (Tekniske Hoejskole, Lyngby (Denmark)).

The angular correlations of photons emitted when positrons annihilate with electrons in single crystals of the rare earth metals Y, Gd, Tb, Dy, Ho, and Er and also in single crystals of certain alloys were measured. A comparison of the results for Y with the calculations of Loucks shows that the independent-particle model gives a good approximation to the angular distribution, although correlation effects probably smear out some of the details. The angular distributions in the c direction in the paramagnetic phases show a rapid drop at low angles followed by a hump, and these features are associated with rather flat electron and hole regions of Fermi surface normal to the c axis. There is a strong correlation between the size of the hump and the ability of the magnetic metals to form a periodic magnetic structure. In the spiral phase of Ho, the hump is much reduced, indicating that the flat electron and hole surfaces are substantially modified by the magnetic ordering. The implications of these results on the relation between the conduction electrons and the magnetic order in rare earth metals are discussed. (auth)

24025 (CONF-670502-, pp 495-505) HYPERFINE INTERACTION IN RARE EARTH METALS AND COMPOUNDS. Brunhart, G. (Brookhaven National Lab., Upton, N. Y.).

The possible origins of the effective magnetic hyperfine fields at the nuclei of the rare earth elements stimulated considerable theoretical and experimental interest. The group of the rare earth elements is formed by filling the 4f electron shell and it is the effect of these 4f electrons that plays the major role in the interpretation of the effective magnetic fields. Although several contributions to the effective field must be considered, in general the magnetic field produced by the 4f electrons dominates. Kondo calculated the 4f contribution for several rare earth elements and predicted very large hyperfine fields, in some cases as much as several thousand kilo-oersted. Exceptions are Gd^{3+} and Eu^{2+}, which have a half-filled 4f shell and whose angular momentum is zero. In these two cases the dominant contribution comes from exchange polarization, i.e., the interaction of the core electrons with unpaired outer electrons. In the case of metallic solids there is also the possibility that the polarization of the conduction electrons might cause significant contribution. Watson and Freeman made extensive studies of such contributions to the effective field. The nuclear polarization that often can be quite easily achieved in rare earth elements is directly dependent on the effective magnetic field and can be measured using polarized neutrons as a probe. Measurements were made on a series of rare earths, from Sm through Tm, using polarized neutrons and polarized targets, and values for the magnitude and sign of the hyperfine constants and effective fields were obtained. (auth)

24026 (SLAC-83) CHARGE DISTRIBUTION FUNCTION IN PERTURBATION THEORY OF CLASSICAL ELECTRODYNAMICS. Chu, E. L. (Stanford Linear Accelerator Center, Calif.). Jan. 1968. Contract AT(04-3)-515. 60p. Dep. CFSTI.

In various problems of classical electrodynamics the solution is often found by solving the Boltzmann–Vlasov equation under proper constraints in six-dimensional phase space. A perturbation representation of the charge distribution function ψ is described in this paper. This representation is derived from the unperturbed distribution function ψ_0 by using a six-dimensional displacement vector ξ. It is shown that if ξ satisfies certain constraints, then $\psi = [\exp(-\vec{\nabla}\cdot\xi)]\psi_0$ satisfies the Boltzmann–Vlasov equation. The constraints which ξ must satisfy are dictated by none other than the Lorentz equation of motion of a charged particle. This constitutes one proof of the equivalence between the Boltzmann–Vlasov equation and the Lorentz equation. This proof may have advantageous aspects, especially in connection with perturbation calculations. As an example, the work of Lee, Mills and Morton on multipole oscillations of a throbbing beam is discussed in detail. The salient features of different kinds of phase spaces are compared by considering simple relativistic particle systems. (auth)

24027 (UCRL-18032) STUDIES ON ELECTRONICALLY EXCITED METASTABLE STATES OF MOLECULES WITH AN ULTRAHIGH-VACUUM MOLECULAR BEAM APPARATUS. Clampitt, R.; Newton, Amos S. (California Univ., Berkeley. Lawrence Radiation Lab.). Dec. 1967. Contract W-7405-eng-48. 53p. Dep. CFSTI.

A molecular-beam apparatus designed for studies on metastable excited states of molecules is described. A molecular beam is crossed by an electron beam to produce electronically excited molecules. These pass into a chamber, operating at ultrahigh vacuum, and are detected by electron ejection from the surface of a photosensitive cathode, Cs_3Sb. The use of a 931A photomultiplier, without its glass envelope, for the detection of excited molecules is described. The detection of photons, positive ions, and metastable molecules by time-resolution and pulse-counting techniques is described. Some results are presented on the effects of different surfaces on the efficiency of detection of excited molecules. Measurements were made on Kr, Ne, N_2, CO, CO_2, H_2, N_2O, and C_2H_4. Electronically excited fragments from N_2O and CO_2 were detected and their threshold energies determined. A prominent resonant state of carbon monoxide at 10.5 eV is reported. (auth)

24028 (AD-666243) ENERGY SPECTRA OF SLOW IONS EMITTED BY A METAL SURFACE AS A RESULT OF ION BOMBARDMENT. Arifov, U. A.; Gruich, D. D. Translated by F. Dion from Dokl. Akad. Nauk Uzb. SSR, 21: (11) No. 5, 20-3(1965). 10p. (FTD-HT-23-799-67). CFSTI.

Energy spectra of slow Cs^+ ions emerging from pure cold and hot Ni, Mo, and W targets were studied by means of a 127° cylindrical capacitor with a resolution $\Delta E = 0.5$ eV. The secondary ions were analyzed at an angle of 135° with respect to the direction of the primary Cs^+ ions, which fell on the target normally. Thermionic-emission and slow-ion peaks are resolved in the spectra. The slow-ion spectrum width is independent of the target temperature; however, it increases in the same order as the atom bond energies in the Ni, Mo, and W targets. With the experimental spectra plotted in semilogarithmic scale, their right-of-maximum branches will register with the straight lines whose slopes are in the same order. This permits presuming that the slow ions acquire their energy from intense oscillation of atoms in that target section excited by the ion bombardment. (auth)

24029 (NP-tr-1641) INVESTIGATION OF THE MASS DISTRIBUTION OF HYDROGEN CLUSTER-IONS IN A MASS SPECTROMETER WITH ENERGY SEPARATION. Buchheit, K. (Technische Hochschule, Karlsruhe (West Germany)). Translation of Thesis. 22p. (CTO-482). Dep. CFSTI. JCL $2.60 fs, $1.10 mf.

The experimental equipment and techniques for measuring the mass distribution are described. The results are presented and discussed. (M.O.W.)

24030 (NP-tr-1642) MAGNESIUM VAPOUR NEUTRALISER. Butusov, V. I.; Kulygin, V. M.; Zubarev, V. F.; Svishchev, V. S. Translated for Culham Lab., Abingdon, Eng., from report IAE-1394. 21p. (CTO-433). Dep. CFSTI, UK. JCL $2.60 fs, $1.10 mf.

The proposed design of the magnesium evaporator ensures a constant density of the supersonic target jet during 8 seconds without using additional heaters to compensate for heat loss on the evaporation of the magnesium. The density of the molecular streams of slow molecules passing through the magnetic trap in OGRA-II is due to the high pressure in the chamber housing the deflecting magnet of the injector rather than to the neutraliser target. The magnesium vapor "transmitted density" in OGRA-II deriving from the neutraliser does not exceed 3.5×10^6 cm^{-3} (10% of the total transmitted density) which corresponds to a lifetime of the 70-keV protons in the trap of about 300 sec. To reduce the molecular flow of slow gas in the vessel of the magnetic trap, it is thus necessary only to reduce the pressure in the chamber housing the injector deflecting magnet. (auth) (UK)

24031 RECENT THEORETICAL AND EXPERIMENTAL STUDIES ON THE SUPERFICIAL INTERACTION BETWEEN MOLECULAR BEAMS AND SOLID BODIES. Nocilla, Silvio (Istituto di Meccanica Razionale, Turin). Aerotechnica, 47: 118-21(June 1967). (In Italian).

The recent research in this field is reviewed. The effects of bombardment of a solid surface by molecular beam are generally called superficial interaction; the current has been shown to be equivalent to an infinite number of bundles of elementary molecular beams incident from all directions, with well-defined intensity and directional distribution. Phenomena resemble those of classical adsorption, except that the molecules do not form a macroscopically quiet gas. Experimental techniques for determination of the generic solid angle, the number of re-emitted molecules, and other parameters are reviewed. Determination of the pressure exerted by a molecular beam is discussed. Models of reemission and of interaction are quoted, with particular emphasis on the author's models and comparison of these with experimental results. (BBB)

24032 CALCULATIONS OF INELASTIC CROSS SECTIONS FOR ROTATIONAL EXCITATION. I. ORBITING RESONANCES FOR THE j = 0 TO j = 2 TRANSITION OF N_2 IN LOW ENERGY COLLISIONS WITH He. Erlewein, W.; von Seggern, M.; Toennies, J. P. (Univ., Bonn). Z. Phys., 211: 35-50(Mar. 12, 1968).

Cross sections for scattering of N_2 (j = 0) molecules on He atoms have been calculated for relative energies below 5×10^{-3} eV (58°K). The time-independent scattering formalism of Arthurs and Dalgarno was used together with an assumed Lennard-Jones type potential with anisotropic P_2 (cos ϑ) terms in the attractive and repulsive parts. The resulting system of coupled differential equations was solved in the distorted wave and close coupling approximations for the differential and integral cross sections for elastic and inelastic (j = 0 → j = 2) scattering. In the integral inelastic cross section several sharp resonances were found to contribute 40% to the cross section at energies below 40°K. The resonance peaks are attributed to orbiting or short-lived compound states since they are also observed in the elastic cross section at energies that are lower by the excitation energy of 1.5×10^{-3} eV. Finally, the effect of varying the potential parameters on the integral inelastic cross section was studied at 50°K and a rough formula for the cross section as a function of the parameters is obtained. The formula shows that a certain ratio of repulsive and attractive anisotropies leads to a small inelastic cross section indicating a mutual cancellation. (auth)

24033 OCHKUR'S METHOD FOR THE EXCITATION OF HYDROGEN ATOMS BY ELECTRON IMPACT. Kang, Ik-ju (Southern Illinois Univ., Carbondale). New Phys. (Korea), 7: 71-4(Dec. 1967).

A relation between the direct and the exchange amplitudes for electron impact excitation of hydrogen atoms is obtained, in the Born-Oppenheimer approximation, up to the second order of q^2/k^2, where q and k_0 refer to the momentum transfer and the momentum of an incoming electron. This high-energy relation is an improvement over the relation obtained originally by Ochkur. This is demonstrated for a process of H(1s) + e → H(2s) + e. (auth)

24034 POLARIZATION OF ELECTRON-IMPACT LIGHT FROM HELIUM. Whitteker, J. H.; Dalby, F. W. (Univ. of British Columbia, Vancouver). Can. J. Phys., 46: 193-200 (Feb. 1, 1968).

The polarization of electron-impact light from helium has been measured for the multiplets 2^3P-2^3S (10 829 Å) and 3^3P-2^3S (3889 Å) for electron energies in the range from threshold to 50 eV. For the 2^3P-2^3S multiplet, the observed polarization rises to 21% near threshold and by means of a curve fitting procedure may be extrapolated to (32 ± 6)% at threshold. For the 3^3P-2^3S multiplet, the observed polarization rises to 11% and may be extrapolated to (15 ± 3)%. (auth)

24035 INCOHERENT SCATTERING CROSS SECTIONS OF GAMMA RAYS IN LEAD IN THE ENERGY REGION 279 TO 1330 keV. Parthasaradhi, K. (Andhra Univ., India). J. Phys., A, 1: 171-?(Jan. 1968).

The effect of electron binding on the incoherent scattering cross sections was studied by subtracting theoretical values of all other partial cross sections from the total experimental cross sections. It is concluded that the Thomas-Fermi model underestimates the effect of electron binding in reducing this cross section in the energy region 279 to 662 keV. (auth) (Uk)

24036 QUASI-FREE STATES. Manuceau, Jerome; Verbeure, Andre (Faculte des Sciences, Marseille). Compt. Rend., Ser. A and B, 266: 32-3(Jan. 8, 1968). (In French).

The quasi-free states of fermions and those of bosons are studied. The corresponding representations are constructed and it is shown that the pure quasi-free states are Fock states. (tr-auth)

24037 CORRELATION PROPERTIES OF GAMMA BEAMS IN THE X-RAY BAND. Kolpakov, A. V.; Kuz'min, R. N. (Moscow State Univ.). JETP Lett. (USSR) (Engl. Transl.), 7: 45-9(Jan. 30, 1968).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 7: 61-5(Jan. 30, 1968).

The correlation properties of gamma and x-ray beams are investigated. A ^{119m}Sn gamma source and a conventional x-ray tube were used. (M.O.W.)

24038 EXPERIMENTAL EVIDENCE AND INTERPRETATION OF THE ORIENTATION OF ATOMS EXCITED IN A HIGH-FREQUENCY DISCHARGE. Lombardi, Maurice; Giroud, Marc (Domaine Univ., Saint-Martin-d'Heres, France). Compt. Rend., Ser. A and B, 266: 60-3(Jan. 8, 1968). (In French).

The analysis of the line widths observed by Hanle effect has led to the prediction and experimental verification of a new orientation method of the states excited in a high-frequency discharge. (tr-auth)

24039 SPECTRUM OF NITROGEN EMITTED BY A BEAM OF STRONGLY ACCELERATED IONS EXCITED BY PASSAGE THROUGH A SOLID TARGET. Denis, Alain; Desequelles, Jean; Dufay, Maurice; Poulizac, Marie-Claude (Faculte des Sciences, Lyon). Compt. Rend., Ser. A and B, 266: 64-7(Jan. 8, 1968). (In French).

The transitions of N II, N III, and N IV emitted by a beam of highly accelerated ions (2 MeV) excited by passage through a thin carbon target were observed. The lifetimes of some levels of N II, N III, and N IV were measured. (tr-auth)

24040 STOCHASTIC WAVE FUNCTION FOR ATOMIC HELIUM. Kalos, M. H. (Courant Inst. of Mathematical Sciences, N. Y.). J. Comput. Phys., 1: 257-76(1966).

A method is given for random sampling which yields a density equal to the ground-state wave function for the helium atom. As an intermediate step, a Green's function for the diffusion operator containing the repulsive interaction is sampled. A technique for generating a density function proportional to ψ^2 is outlined. Attention is paid to the development of estimators with finite variance. Results are shown for the electron density and for $\langle r^2 \rangle$. The latter agrees well with previous numerical results. (auth)

24041 POLARIZATION EFFECTS IN COMPTON SCATTERING. Raju, A. S.; Rao, J. Rama; Lakshminarayana, V. (Andhra Univ., Waltair, India). J. Phys., A, 1: 251-5(Mar. 1968).

An experimental investigation was made of the polarization effects in the inelastic scattering of 662 keV photons from a 10 Ci ^{137}Cs source, using a polarization analyzer equipped with sum-coincidence arrangement. The experiments were conducted at four scattering angles (45, 60, 75, and 90°) and three azimuthal angles (30, 60, and 90°). The coincidence rates in two different planes were determined simultaneously. The results are in satisfactory agreement with the predictions of the Klein-Nishina theory. (auth)

24042 PENETRATION RANGE OF ENERGETIC IONS IN IRRADIATED AMORPHOUS TARGETS. Kanaya, Koichi (Elec-

trotechnical Lab., Tokyo); Shimizu, Keizo; Ishikawa, Yoshimitsu. Denki Shikensho Iho, 31: 1226-8(1967).

Quasi-elastic scattering theory is used to formulate the range of a beam of moderate-velocity charged particles in a thin film of amorphous material. Energy losses from both electronic and nuclear collisions are considered. Ranges for various particle and target combinations calculated by the equation obtained are in generally good agreement with experimental results of others. (A.G.W.)

24043 COLLISION OF AN ATOM AND A DIATOMIC: THE DISTORTED WAVE EXPANSION. Thiele, Everett; Weare, John (Johns Hopkins Univ., Baltimore). J. Chem. Phys., 48: 2324-31(Mar. 1, 1968).

Higher-order terms are considered in Mott and Jackson's distorted wave treatment of the atom–diatomic collision problem. In addition to the physically realistic requirement of a soft interaction, it is shown that the expansion is best for light incident atom with low kinetic energy. It is also shown that for an n-quantum transition, it is necessary to go to at least the nth order in the expansion in order to obtain a reasonably accurate result. A simple second-order formula is given for two-quantum transitions. Numerical evaluation of the second- and third-order terms has been carried out for a number of transitions and the results are compared with Secrest and Johnson's exact values. A rearrangement of the distorted wave expansion for one-quantum transitions, which leads to a wider range of applicability, is presented. (auth)

24044 TRANSFORMATION MATRIX FOR PERIODIC ELECTROSTATICALLY FOCUSED ELECTRON BEAMS. Gopinath, A. (University Coll. of North Wales, Bangor). Int. J. Electron., 23: 217-20(1968).

A transformation matrix is developed for noise propagation in periodic electrostatically focused beams. (auth) (UK)

24045 SCALLOPING BEHAVIOUR OF COMPRESSED ELECTRON BEAMS IN VARYING MAGNETIC AND ELECTRIC FIELDS. Gandhi, Om P. (Univ. of Utah, Salt Lake City). Int. J. Electron., 23: 283-98(1968).

The scalloping behavior of electron beams in rapidly increasing magnetic fields is studied. It is shown that in order to reduce the scalloping on these compressed beams it is necessary that the beam should encounter a relatively slow varying magnetic field upon being launched into it. The magnetic field can rise quite fast to almost 80 to 90% of the final value in the intermediate region, followed by another region of smooth variation on to the constant field in the interaction region. The beam scalloping is critically dependent on the magnetic field format, and increases rapidly if the entrance conditions are "imperfect." For compressed Brillouin beams the beam ripple rises $\sqrt{B_f/B_i}$ times faster than for constant-field beams for given deviation from ideal launching conditions. For backward-wave oscillator applications, where it is necessary to vary the beam voltage, it is advantageous to accelerate the beam at the end of magnetic compression. Magnetically compressed Brillouin beams are shown capable of further compression upon acceleration without undue increase in scalloping. (auth) (UK)

24046 A PROPOSED METHOD TO MEASURE THE SCATTERING OF ELECTRONS BY ELECTROMAGNETIC WAVES. Farago, P. S. (Univ. of Edinburgh). Phys. Lett., 26A: 391-2 (Mar. 11, 1968).

The measurement of the electron optic refractive index of a laser beam is proposed. The method is based on a predicted shift of the fringes produced in an electron interference microscope. (auth)

24047 ADIABATIC HYPOTHESIS APPLIED TO HIGH-ENERGY CHARGE-TRANSFER COLLISIONS INVOLVING RARE GASES. Williams, F. J. (Laval Univ., Quebec). J. Phys., B, 1: 132-4(Jan. 1968).

The cross-section values for high-energy charge-transfer collisions involving the rare gases, measured recently by Wittkower and Gilbody, are analyzed with the use of the adiabatic hypothesis. If polarization effects are included in the change of internal energy of the collision it is indicated that the main maxima in the cross-section values would arise from 10/01 collisions, while the secondary maxima would arise from 1*0/01 or 1*0/01* collisions, in which the excitation energy of 1* is in the vicinity of the second ionization potential of the relevant atom. (auth) (UK)

24048 APPLICATION OF A SIMPLIFIED SECOND BORN APPROXIMATION TO THE SCATTERING OF ELECTRONS AND PROTONS BY HYDROGEN ATOMS. Holt, A. R.; Moiseiwitsch, B. L. (Queen's Univ. of Belfast). J. Phys., B, 1: 36-47(Jan. 1968).

A simplification of the second Born approximation, in which the terms arising from coupling to the lowest N levels are evaluated exactly and those arising from coupling to all the higher levels with principal quantum numbers $n \geq N + 1$ and to the continuum states are determined approximately by using the closure relation, is employed to investigate the elastic scattering of electrons by hydrogen atoms and the $1s \rightarrow 2s$ and $1s \rightarrow 2p$ excitations of atomic hydrogen by electron and proton impact. For the case of elastic scattering the inclusion of coupling to higher states increases the total cross section above the first Born approximation at all electron-impact energies. However, for the $1s \rightarrow 2s$ and $1s \rightarrow 2p$ excitations the effect of coupling to states with principal quantum numbers $n \geq 3$ is opposite to that of coupling to the $n = 2$ level, and brings the total cross sections closer to the first Born approximation at the highest impact energies ($\gtrsim$100 eV for incident electrons). (auth) (UK)

24049 POSITRON ANNIHILATION IN HELIUM. Houston, S. K. (Queen's Univ. of Belfast). J. Phys., B, 1: 34-5(Jan. 1968).

The annihilation rate of positrons in helium gas is proportional to an effective electron number Z, which was calculated using the positron scattering wave function obtained by Houston and Moiseiwitsch in 1967. The value $Z = 4.61$ was obtained, compared with the experimental value $Z \simeq 3.9$ obtained by Falk et al. in 1965. (auth) (UK)

24050 ELASTIC SCATTERING OF ZERO-ENERGY POSITRONS BY HYDROGEN AND HELIUM ATOMS. Houston, S. K.; Moiseiwitsch, B. L. (Queen's Univ. of Belfast). J. Phys., B, 1: 29-33(Jan. 1968).

Scattering lengths for elastic collisions between zero-energy positrons and atoms of hydrogen and helium were calculated, using Kohn's variational method together with trial functions that make explicit allowance for the correlation between the incident positron and the atomic electrons and depend upon three exponential parameters as well as a number of linear parameters. For the case of atomic hydrogen the value $-1.78\ a_0$ was obtained for the scattering length, employing 21 linear parameters, compared with the accurate value $-2.10\ a_0$ calculated by Schwartz in 1961 also using Kohn's variational method. For helium, using a Hartree ground-state wave function, the scattering length was found to be $-0.398\ a_0$, again employing 21 linear parameters. This is somewhat larger than the value $-0.575\ a_0$ calculated by Kestner et al. in 1965, using a method based on a pseudopotential, and the value $-0.546\ a_0$ calculated by Hashino in 1966, using the method of polarized orbitals. (auth) (UK)

24051 PENNING IONIZATION BY METASTABLE HELIUM ATOMS. Bell, K. L.; Dalgarno, A.; Kingston, A. E. (Queen's Univ. of Belfast). J. Phys., B, 1: 18-22(Jan. 1968).

Values of the van der Waals interaction between the $2\ ^1S$ and $2\ ^3S$ metastable states of helium and the systems Ne, Ar, Kr, Xe, H_2, N_2, O_2, CH_4, Li, Na, K, Rb, Cs, and O are computed. The values are used to determine Penning ionization probabilities from the experimental data, with results differing significantly from an earlier analysis. Estimates are made of Penning ionization cross sections for $He(2\ ^3S)$ in the alkali metals, in atomic oxygen and in methane, for which no experimental data exist. (auth)

24052 DIPOLE PROPERTIES OF THE METASTABLE STATES OF HELIUM. Victor, G. A. (Queen's Univ. of Belfast); Dalgarno, A.; Taylor, A. J. J. Phys., B, 1: 13-17(Jan. 1968).

A variational method is used to calculate the effective electric-dipole oscillator strength distributions of the ground and metastable states of helium. Accurate values are obtained of the refractive indices, the long-range interactions, and the mean excitation energies controlling the absorption of a beam of fast charged particles. (auth) (UK)

24053 A SIMPLE ANALYTICAL FORM OF THE THOMAS–FERMI SCREENING FUNCTION AND OF FIRSOV'S ATOMIC INTERACTION POTENTIAL. Wedepohl, P. T. (Univ. of Witwatersrand, Johannesburg). J. Phys., B, 1: 307-4(Mar. 1968).

The Thomas–Fermi screening function $\phi(x)$ is shown to be accurately described by the expression $317 \times \exp(-6.62x^{\frac{1}{4}})$ in the range $0.3 < x < 16$. The consequent form of the Thomas–Fermi electron density distribution is derived, and Firsov's atomic interaction potential is shown to have the form $E = B \exp(-\alpha r^{\frac{1}{4}})$, where B and α are constants of known Z dependence and r is the internuclear distance. It is suggested that a potential of the type $E' = A' \exp(-k' r^{\frac{1}{4}})$ gives a better representation of the interaction potential over a wider range of energies and distances, and explicit values of A' and k' are given for copper–copper interactions. The Z dependence of A' and k' is not, however, obvious. (auth) (UK)

24054 THE FREE–FREE TRANSITIONS OF He^-. John, T. L. (University Coll. of South Wales, Cardiff). Mon. Notic. Roy. Astron. Soc., 138: 137-41(1968).

The He^- free–free absorption coefficient is calculated using phase shifts of Williamson & McDowell, and of LaBahn & Callaway, for elastic scattering of electrons by neutral helium atoms. (auth) (UK)

24055 CALCULATIONS OF ELECTRON SPIN POLARIZATION FOR ELECTRON–MOLECULE COLLISIONS. Yates, Albert C. (Indiana Univ., Bloomington). Phys. Rev. Lett., 20: 829-31(Apr. 15, 1968).

A model is described which is capable of accurately predicting electron spin polarization for molecular targets, and consequently serves as a guide toward predicting polarization in other molecular cases. (M.O.W.)

24056 SPIN POLARIZATION IN ELECTRON SCATTERING FROM MOLECULES. Walker, D. W. (Univ. of Melbourne). Phys. Rev. Lett., 20: 827-8(Apr. 15, 1968).

Theoretical results, obtained from the coherent superposition of the waves scattered from the individual atoms, are presented for the spin polarization of 300-eV electrons scattered by C_2H_5I and I_2 molecules, and are found to be in good agreement with experiment. (auth)

24057 POLARIZATION OF ATOMIC RADIATION EXCITED BY ELECTRON IMPACT AT THRESHOLD. McFarland, Robert H. (Univ. of California, Livermore); Mittleman, Marvin H. Phys. Rev. Lett., 20: 899-900(Apr. 22, 1968).

Arguments are presented to show the discrepancies in theories on the polarization of He radiation excited by electrons with energy in the vicinity of threshold. (M.O.W.)

24058 EVALUATION OF SLOWLY CONVERGING RADIAL INTEGRALS OCCURRING IN ATOMIC COLLISION PROBLEMS. Belling, J. A. (University Coll., London). J. Phys., B, 1: 136-8(Jan. 1968).

In atomic scattering calculations it is often required to evaluate integrals of the form $G(R) = \int_R^\infty r^{-n}F(r)F'(r)\,dr$ where F and F′ are radial functions for a colliding particle. Owing to slow convergence, direct numerical integration may fail to give accurate results. A method employing asymptotic expansions was developed for the fast, accurate evaluation of such integrals. (auth) (UK)

24059 THE VARIATIONAL FUNCTION FOR H_2^+ (FIRST EXCITED STATE). Hariharan, P. C.; Khubchandani, P. G. (Bhabha Atomic Research Centre, Trombay, India). J. Phys., B, 1: 134-6(Jan. 1968).

For the $2p\sigma$ state of the H_2^+ molecule the function $\psi = (1 + pR\xi)\exp(-\alpha R\xi)\sinh(\beta R\eta)$, which is separable in elliptic coordinates, was studied. The calculated energy is lower than that of any of the existing variational functions for $R > 2$. The integrals $\langle X^2\rangle$ and $\langle Z^2\rangle$, as well as the energy values for different nuclear separations, were also calculated. (auth) (UK)

24060 SOME REMARKS ON INTEGRAL EXPRESSIONS FOR SCATTERING AMPLITUDES. Rudge, M. R. H. (Queen's Univ., Belfast). J. Phys., B, 1: 130-1(Jan. 1968).

The work of Day et al., Kang and Sucher, and Kang and Foland is discussed. It is shown that their expression for the scattering amplitude contains a divergent phase factor, and it is argued that the term in the Born–Oppenheimer amplitude that they describe as "fictitious" is not so. (auth) (UK)

24061 THE M X-RAY ABSORPTION OF Yb. Combley, F. H.; Stewardson, E. A.; Wilson, J. E. (Univ. of Leicester, Eng.). J. Phys., B, 1: 120-7(Jan. 1968).

The M_V, M_{IV}, and M_{III} absorption edges of Yb in YbF_3 and in the metal were detected and the variation in the absorption coefficient of Yb, in these regions, was computed. The M_V line absorption of Yb^{3+} was studied in detail and shown to be absent for Yb metal. This has been cited as evidence supporting the conclusion, from magnetic studies, that Yb is a divalent metal, possessing a completely full 4f shell. A shift of the M_V and M_{IV} edges for Yb in YbF_3 and Yb_2O_3 to positions some 10 eV higher in energy than those for the metal was observed and is discussed. (auth) (UK)

24062 L SPECTRUM OF YTTERBIUM. Deodhar, G. B.; Singh, R. B.; Varma, P. P. (Univ. of Allahabad, India). J. Phys., B, 1: 103-5(Jan. 1968).

A focusing x-ray spectrograph of Cauchois type was used to find five new forbidden lines $L_IN_I\lambda$ 1236.80 x.u., $L_{II}N_{VI}\lambda$ 1240.63 x.u., $L_{II}N_{III}\lambda$ 1284.43 x.u., $L_{III}N_{VI,VII}\lambda$ 1384.80 x.u. and $L_{III}N_{III}\lambda$ 1438.75 x.u. for ytterbium. The transitions $L_{II}O_I$, $L_{III}O_I$, $L_{III}O_{IV,V}$, L_IM_V, L_IO_I, $L_IO_{IV,V}$, $L_{II}M_{II}$, and $L_{III}O_{II,III}$ reported earlier by Allais were confirmed. The transitions L_IM_{IV}, $L_{II}O_{II,III}$, and $L_{III}M_{II}$ reported by Allais could not be confirmed. (auth) (UK)

24063 ABSOLUTE CROSS SECTIONS FOR IONIZATION AND EXCITATION OF CO_2 BY ELECTRON IMPACT. McConkey, J. W.; Burns, D. J.; Woolsey, J. M. (Queen's Univ. of Belfast). J. Phys., B, 1: 71-6(Jan. 1968).

Absolute cross sections for simultaneous ionization and excitation of CO_2 by electron impact were measured using a crossed-beam technique. The maximum value of the cross section of the $B\,^2\Sigma_u^+$ level is 22.4×10^{-18} cm² and that of the $A\,^2\Pi_u^+$ level is 74.4×10^{-18} cm². Relative cross sections within the vibrational bands are given. The excitation functions are similar in shape to the total ionization function. (auth) (UK)

24064 PHOTOELECTRIC CROSS SECTIONS OF GAMMA RAYS IN Al, Cu, Sn, W, Au, AND Pb IN THE ENERGY REGION 50 TO 208 keV. Parthasaradhi, K. (Andhra Univ., Waltair, India). J. Phys., A, 1: 256-8(Mar. 1968).

The total photoelectric cross sections of gamma rays were determined by subtracting the theoretical scattering cross sections from the experimental total gamma-ray cross sections of Wiedenbeck in the energy region 50 to 208 keV. The values obtained are compared with the latest theoretical values of Rakavy and Ron, Schmickley and Pratt, and the compiled data of Hubbell and Berger. Agreement is observed between the theoretical and experimental values within 5%, except in lead at 50 and 105 keV. A systematic measurement of total gamma-ray cross sections in lead at these energies is suggested. (auth) (UK)

24065 ELECTRON-INDUCED CASCADE SHOWERS IN COPPER, TIN, AND LEAD. Crannell, Carol Jo Argus. Stanford, Calif., Stanford Univ., 1967. 106p.

Thesis.

Electromagnetic cascade showers induced by 900-MeV electrons have been studied in copper, tin, and lead targets. A small, parallel incident beam with negligible background contamination was employed to achieve good resolution and undistorted development of the shower. The three-dimensional spatial distribution of energy deposition was measured with a CsI(Tl) detector placed at various positions in a small hole in an otherwise solid block of material. Measurements were extended to radii of 7 Molière lengths and depths of 30 or more radiation lengths. Additional data for showers induced by 200-MeV electrons incident on lead are also presented. The results of this experiment are compared with the results of previous experiments and with the predictions of recent Monte Carlo calculations. The measured longitudinal distribution of energy is in good agreement with theoretical predictions, while the radial distributions show an unpredicted dependence on the atomic number of the target material. (Disser. Abstr.)

24066 NONADIABATICITY CORRECTIONS TO THE BORN–OPPENHEIMER APPROXIMATION WITH CALCULATIONS FOR MESIC AND ELECTRONIC HYDROGEN MOLECULAR IONS. Patterson, Malcolm Robert. Knoxville, Tenn., Univ. of Tennessee, 1967. 226p.

Thesis.

For generalized hydrogen molecular ions and adiabatic approximation is excellent if $\epsilon/4$, the ratio of the mass m_3 of the binding particle to the total mass, is small (e.g., H_2^+). For $(p\mu p)^+$, $\epsilon \approx 0.213$, the large mass ratio introduces correction terms to the adiabatic approximation. A detailed formalism using rotation matrices and exact two-center "electronic" functions was worked out. The nonadiabatic corrections take the form of couplings between different electronic states. Coupled radial equations involving as many as six electronic states have been solved for ground and excited states of $(p\mu p)^+$, $(d\mu d)^+$, $(t\mu t)^+$, $(\mu e\mu)^+$, and $(pep)^+$. The resultant wave functions were used to calculate the probability 2γ that the lepton and either nucleus coincide. For ortho $(p\mu p)^+$ a new upper limit is $2\gamma_0 = 1.12$, as compared to the adiabatic value $2\gamma_0 = 1.165$. Variational calculations supply the lower limit $2\gamma_0 = 1.00$. Using the value $2\gamma_0 = 1.12$, the weak interaction coupling constants for muon capture in hydrogen are consistent with those for muon capture in He^3 and Ca^{40} at the axial vector coupling constant values $g_A^{(\mu)}/g_A^{(\beta)} = 1.26\ (^{+0.3}_{-0.4})$ and the induced pseudoscalar coupling constant values $g_p^{(\mu)}/g_A^{(\mu)} = 16.2 \pm 3.2$. (Disser. Abstr.)

Cosmic Radiation

Refer also to abstracts 23022, 23259, 23298, 23926, 23950, 24141, 24533, 24534, 24545, 24546, 24626, 24627, 24677, and 24686.

24067 (SC-T-68-1514) OBSERVATIONS REGARDING THE NEUTRON SPECTRUM IN THE HIGH ATMOSPHERE ON THE OCCASION OF THE SOLAR ECLIPSE, 12 NOVEMBER 1966. Bosch, H. E.; Hanza, O.; Lorenzetti, J.; Sandor, T.; Dolinkue, R. Translated by Marcel I. Weinreich (Sandia Corp., Albuquerque, N. Mex.), from Paper Presented at International Solar Eclipse Symposium, Sao Paulo, Brazil, Feb. 5–9, 1968. 21p. (CONF-680208–1). Dep. CFSTI. JCL $2.60 fs, $1.10 mf.

A system was developed for the detection of fast neutrons by means of scintillators. With the aid of transistorized circuits (as well as printed ones) the system in question was miniaturized in order to install it as a payload in the rocket ORION II. The corresponding environmental tests were performed, since high-vacuum equipment had to be constructed. Furthermore, payload launches of the rocket ORION II were carried out in order to detect electromagnetic radiation, as well as fast neutrons, the first launching at the moment of the total eclipse, while the other was made three hours later. The signal disappeared after the second shot. According to the data collected, the first shot revealed a flux magnitude of the order of 0.1 neutron/cm² sec. (auth)

24068 COSMIC-RAY DISTRIBUTION AND THE ACCEPTANCE VECTORS OF DETECTORS. III. Chirkov, N. P.; Altukhov, A. M.; Krymskii, G. F.; Krivoshapkin, P. A.; Kuz'min, A. I.; Skripin, G. V. (Inst. of Cosmophysical Studies and Aeronomy, Novosibirsk, USSR). Geomagn. Aeron. (USSR) (Engl. Transl.), 7: 503-13(1967).

Translated from Geomagn. Aeron., 7: 620-31(1967).

The results of computations of the acceptance vectors of 72 neutron-monitor stations of the global network with a dipole and real representations of the geomagnetic field for the first and second spherical harmonics of cosmic-ray distribution are reported. The computations were performed for minimum and maximum solar activity. (auth)

24069 INFLUENCE OF A PENUMBRA ON THE EFFECTIVE CUTOFF RIGIDITY OF COSMIC RAYS. Dorman, L. I.; Gushchina, R. T. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio-Wave Propagation, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.), 7: 500-2(1967).

Translated from Geomagn. Aeron., 7: 616-19(1967).

The results are reported of computations of the effective geomagnetic cutoff rigidity in the presence of a penumbra and of its variation at geomagnetic latitudes 0, 30, 40, and 50° as recorded by means of various components, such as: on low satellites and in the stratosphere; the neutron component at a height of 10 km, at mountain level, and at sea level; and the hard component at a height of 10 km, at sea level, and underground at depths of 3 and 7 mwe. The expected variations of effective cutoff rigidity are also found for a constant geomagnetic field when recording primary variations of the increase type from chromospheric flares and from various kinds of modulating effects with different instruments. (auth)

24070 INCREASE IN COSMIC-RAY INTENSITY PRECEDING FORBUSH EFFECTS. Dorman, L. I.; Kaminer, N. S.; Kebuladze, T. V. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio-Wave Propagation, Moscow. Inst. of Geophysics, Tbilisi, USSR). Geomagn. Aeron. (USSR) (Engl. Transl.), 7: 580-1(1967).

Translated from Geomagn. Aeron., 7: 714-15(1967).

Data on the variations of the neutron component of cosmic rays from several stations for 1957–1960 were used to determine the nature of the increase. Eighteen magnetic storms (moderate and large) accompanied by Forbush effects with an amplitude of not less than 3% were selected. The average variation in intensity preceding a Forbush effect was found for all these storms at each observatory. Each station revealed an increase in intensity several hours prior to the Forbush effect. (W.D.M.)

24071 MEASUREMENT OF THE EPITHERMAL NEUTRON FLUX IN THE UPPER LAYERS OF THE ATMOSPHERE BY THE INDIUM-ACTIVATION METHOD. Efimov, Yu. E.; Romanov, A. M. (Ioffe Inst. of Physics and Tech., Leningrad). Geomagn. Aeron. (USSR) (Engl. Transl.), 7: 583-4(1967).

Translated from Geomagn. Aeron., 7: 717-18(1967).

The purpose of this study was to measure the flux of epithermal albedo neutrons in the upper atmosphere by the In-activation method. The advantages of this method are discussed. The measurements were made in 1965–1966 at a geomagnetic latitude $\lambda = 47°N$ and at heights corresponding to depths in the atmosphere from 40 to 8 g/cm². (W.D.M.)

24072 FLUCTUATIONS IN THE LONGITUDINAL AND LATERAL DEVELOPMENT OF E.A.S. AND THEIR INFLUENCE UPON THE SPECTRUM OF THE RATIO OF THE MUON TO ELECTRON COMPONENT DENSITY. Gawin, Jerzy (Inst. of Nuclear Research, Lodz, Poland); Hibner, Juliusz; Zawadzki, Aleksander; Maze, Roland; Wdowczyk, Jerzy. Nukleonika, 13: 29-36(1968).

The fluctuations of mu component due to the longitudinal and lateral development of the EAS were found experimentally in an indirect way. The value of their standard deviation $\sigma = 0.34 \pm 0.05$. This value seems to be in a good agreement with a theoretical one ($\sigma = 0.30$) calculated in the paper 1. The apparently small value of σ can be satisfactorily explained on the basis of a quite strong negative correlation between the mean muonic radius r_μ and the EAS size N_e at constant total energy E_0. This negative correlation is suggested in the quoted theoretical work. It leads to a positive correlation between Δ_μ and Δ_e when measured in the central part of a shower of constant size. The decreasing of the $\sigma(\Delta_\mu/\Delta_e)$ as compared to the $\sigma(N_\mu/N_e) = 0.51$ results from the compensation due to the mentioned positive $\Delta_\mu - \Delta_e$ correlation. (auth)

24073 EFFECTS PREDICTED BY THE FIREBALL MODEL UNDER THE ASSUMPTION OF PLANCK'S MOMENTUM SPECTRUM. Coghen, Tomir (Inst. of Nuclear Research, Krakow). Nukleonika, 13: 41-53(1968).

Distributions of transverse momentum predicted by the fireball model were computed under the assumption of Planck's momentum spectrum for various values of mean pion energy in the rest frame of the fireball. Correlations between transverse momentum and emission angles were also investigated. Angular distributions of artificial "fireballs" obtained by random sampling were analyzed. Sampling and all calculations were carried out by means of the GIER computer. (auth)

24074 ANOMALOUS INTERACTIONS OF SECONDARY PARTICLES EMITTED FROM RELATIVISTIC HEAVY PRIMARY INTERACTIONS. Judek, B. (National Research Council of Canada, Ottawa). Can. J. Phys., 46: 343-58(Mar. 1, 1968).

Interaction mean free paths of relativistic secondary particles emitted from interactions of heavy primary cosmic-ray nuclei in emulsions were measured. The results show that among the Be, Li, He, and singly charged secondary nuclei there are particles present which interact with a cross section several times higher than the expected geometrical value. The stars produced by these particles have the characteristics of ordinary nuclear interactions. There appears to be no interpretation of these observations in terms of any known particle phenomena. (auth)

24075 POSITIVE–NEGATIVE RATIO OF MUONS AT SEA LEVEL IN THE RANGE 3 TO 360 GeV. Baber, S. R.; Nash, W. F.; Rastin, B. C. (Univ. of Nottingham, Eng.). Nucl. Phys., B4: 549-58(1968).

Measurements were made of the positive–negative ratio of near vertical muons at sea level in the range 3 to 360 GeV. The gradual increase of the charge ratio with energy above ≈50 GeV observed in the preliminary experiment using this instrument has been substantiated by the present data. The results are examined in terms of various theoretical predictions. (auth)

24076 MOMENTUM SPECTRUM OF MUONS AT SEA-LEVEL IN THE RANGE 3 TO 1000 GeV/c. Baber, S. R.; Nash, W. F.; Rastin, B. C. (Univ. of Nottingham, Eng.). Nucl. Phys., B4: 539-48(1968).

Extended measurements of the sea-level momentum spectrum of muons incident at zenith angles close to the vertical were made in the range 3 to 1000 GeV/c. The spectrum obtained agrees well with that predicted by a diffusion model involving 100% pion production. The exponent of the pion production spectrum is found to be –2.65. (auth)

24077 STUDY OF THE ENERGY SPECTRA OF MUONS UNDERGROUND. Craig, R.; Osborne, J. L.; Wolfendale, A. W.; Young, E. C. M. (Univ. of Durham, Eng.). J. Phys., A, 1: 61-71(Jan. 1968).

The energy spectra of atmospheric muons at sea level and underground were calculated from assumed forms of the primary spectrum, the mass composition, and the interaction model, and from various depth–intensity relations at great depths. The mean muon energies in the vertical direction at a depth of 7500 mwe were derived and found to range from 286 to 393 GeV according to the assumptions used. The energy spectra of neutrino-induced muons underground were also calculated. The mean energies were found to be much lower than for those of atmospheric origin, being typically in the region of some tens of GeV. It is shown that the muon rate is sensitive to the mass of the (hypothetical) intermediate boson, and the mean muon energy is largely dependent on the saturation energy of an assumed linearly increasing cross section for the inelastic neutrino interaction. It is indicated that more accurate measurements of both the rate and the mean energy of the neutrino-induced muons will provide useful information on the neutrino cross sections at very high energies. (auth) (UK)

24078 AN INVESTIGATION OF COSMIC RAYS UNDERGROUND USING A SCINTILLATOR STACK. V. A STUDY OF GROUPS OF MUONS PENETRATING UNDERGROUND. Barton, J. C. (Northern Polytechnic, London). J. Phys., A, 1: 43-54 (Jan. 1968).

The scintillator stack was operated for eight months in coincidence with two additional counters placed in the same tunnel at

distances up to 6.3 m away. It is shown that this arrangement is satisfactory for studying muon showers and that the stack alone can be used to distinguish groups of muons. The measured rate of pairs of muons is compared with results from other experiments at various depths. The results are compatible with Greisen's expression for the muon density in air showers; in the extrapolated region close to the shower axis it is necessary to assume that the muon density rises more sharply than at greater distances, but there is no evidence for very strongly collimated groups of muons. (auth) (UK)

24079 RANGE FLUCTUATIONS FOR MUONS OF ENERGY UP TO 10^6 GeV. Osborne, J. L.; Wolfendale, A. W.; Young, E. C. M. (Univ. of Durham, Eng.). J. Phys., A, 1: 55-60(Jan. 1968).

Recent measurements on cosmic rays deep underground have led to a study of the effect of fluctuations in range for muons of energy up to 10^6 GeV and ranges down to 15,000 mwe. The results of the calculations are given; in these calculations, which are more extensive than hitherto, an examination is made of the effect on the muon survival probabilities deep underground of different assumptions as to the form of the cross section for the contributions from nuclear and bremsstrahlung losses and different magnitudes of the energy loss coefficients. Survival probability curves are given from which the enhancement in underground intensity can be calculated for any sea-level muon spectrum, and results are also given of the actual enhancement factors for sea-level spectra having constant exponents. (auth) (UK)

24080 SPECTRUM OF HIGH-ENERGY COSMIC-RAY MUONS AT A ZENITH ANGLE OF 75^0. Stefanski, R. J. (Yale Univ., New Haven); Adair, R. K.; Kasha, H. Phys. Rev. Lett., 20: 950-2(Apr. 22, 1968). (BNL-12324).

The energy spectrum of high-energy cosmic-ray muons was measured at an angle of 75° from the vertical. The results show that the direct muon production inferred from underground measurements of muons with energies over 1000 GeV is not observed in these spectrograph measurements at energies up to 300 GeV. (auth)

24081 FLUX OF PRIMARY COSMIC-RAY PARTICLES WITH $Z \geq 3$. Fody, S. A.; Friedlander, M. W.; Hasegawa, H.; Klarmann, J. (Washington, Univ., St. Louis). Planet, Space Sci., 16: 253-4(Feb. 1968). (NP-17105).

A value is reported for the flux of heavier particles ($Z \geq 3$) obtained from examination of the set of nuclear photographic emulsions used by Friedlander and Karman [(1967) Planet. Space Sci. 15, 619] for He nuclei. The flight trajectory corresponds to a mean geomagnetic cutoff of 4.5-GV rigidity or 1.5 GeV/nucleon kinetic energy for multiply charged particles, and hence attention is restricted to particles having at least this energy. The flux of particles with $Z \geq 3$ is found to be $J(Z \geq 3) = 11.5 \pm 0.5$ particles/$m^2 \cdot$ sec ster, which is considerably higher than had been expected on the basis of data obtained during the previous period of low solar activity. (UK)

24082 ANALYSIS OF EXPERIMENTAL RESULTS ON FLUCTUATIONS OF MUON AND ELECTRON NUMBERS IN EXTENSIVE AIR SHOWERS. Adcock, C.; de Beer, J. F.; Oda, H.; Wdowczyk, J.; Wolfendale, A. W. (Univ. of Durham, Eng.). J. Phys., A, 1: 82-8(Jan. 1968).

The theoretical results derived in the previous paper by de Beer et al. in 1968 were compared with experimental observations, with reference to the fluctuations in the total numbers of muons and electrons and to the variation of the mean number of muons with shower size. It is found that the derivation of accurate parameters from experimental data is very difficult in view of the presence of a variety of bias effects. However, good agreement appears, in general, when comparison is made of the predictions of the authors' preferred model (which assumes a CKP type of energy distribution for the secondary pions from high-energy interactions). The nature of the mass composition of the primaries is still unclear in view of the rather low sensitivity of most parameters to the mass spectrum. What evidence there is, from the (N_μ, N_e) relation, gives only a very slight indication of a change in the primary composition above 10^{15} eV. (auth) (UK)

24083 THEORETICAL ANALYSIS OF EXTENSIVE AIR SHOWERS. II. FLUCTUATIONS OF MUON AND ELECTRON NUMBERS. de Beer, J. F.; Holyoak, B.; Oda, H.; Wdowczyk, J.; Wolfendale, A. W. (Univ. of Durham, Eng.). J. Phys., A, 1: 72-81(Jan. 1968).

The results reported form a continuation of the analysis given by de Beer et al. in 1966. In the present work an examination is made of the fluctuations expected in the electron and muon components from shower to shower, with particular regard to the number, lateral distribution, and height of origin of the muons. It is shown that fluctuations can affect considerably the picture of showers drawn from results with practical air shower arrays, largely through the correlations that exist between the various components. The important problem of deriving results of significance to high-energy nuclear physics and to astrophysics is studied, and it is shown that the relative fluctuation of the muon number in showers of fixed size has some sensitivity to the characteristics of high-energy interactions, whereas the relative fluctuation of the shower size for constant muon number is sensitive to the mass composition of the primary particles. (auth) (UK)

24084 ENERGY SPECTRUM OF COSMIC-RAY NEUTRONS AT SEA LEVEL IN THE RANGE 20 to 4000 GeV. Ashton, F.; Coats, R. B. (Univ. of Durham, Eng.). J. Phys., A, 1: 169-70 (Jan. 1968).

A study was made of the production of bursts by neutral cosmic-ray particles, presumably neutrons, in the energy range 20 to 4000 GeV. The energy spectrum is found to exhibit a deficiency above 100 GeV when compared with that derived from the primary nucleon spectrum, given by a number of authors, assuming a constant attenuation length. The discrepancy most likely represents a change of attenuation length with energy, but an alternative explanation involving quark production cannot be ruled out. (auth) (UK)

24085 RADIO PULSES FROM EXTENSIVE AIR SHOWERS AS A RESULT OF MOVEMENT OF SLOW ELECTRONS IN THE ATMOSPHERIC ELECTRIC FIELD. Charman, W. N. (Atomic Energy Research Establishment, Harwell, Eng.). J. Atmos. Terrest. Phys., 30: 195-204(Feb. 1968).

The numbers, energies, and lifetimes of slow ionization electrons produced in the extensive air showers caused by high-energy cosmic-ray primaries are discussed, and it is shown that the electric field in the atmosphere causes these electrons to accelerate to a drift velocity in the direction of the field. A suitably placed observer experiences this acceleration as a change of electric field, the lifetimes of the electrons and the shower dimensions being such as to make this change of field observable at radio frequencies (~10 MHz). Calculations indicate that this mechanism should be at least as effective as other previously suggested radio emission mechanisms for showers at high zenith angles, although, since the normal fine-weather electric field is essentially vertical, the mechanism is relatively ineffective for showers from near the zenith. (auth) (UK)

24086 ANTINUCLEON COMPONENT OF THE PRIMARY COSMIC RAY FLUX. Wayland, James Robert Jr. Tucson, Ariz., Univ. of Arizona, 1967. 50p.

Thesis.

A Fokker–Planck diffusion equation was solved for the diffusion and acceleration of cosmic rays. A time-independent solution was obtained by assuming that the contributions to the present intensity of particles injected at a uniform rate during all past times is equivalent to summing the intensities over all future time of particles injected at a given time. Continuous deceleration and fluctuations in acceleration were used to explain the energy spectrum. This gives a general expression for a power law spectrum in which the exponent varies as $\gamma = 0.09 \ln (E/m) + 0.9$ thus allowing a very good fit to the experimental energy spectrum. A previously developed expression for the production of antiprotons was applied to obtain an injection spectrum. This and the above solutions were then applied to three extreme cases of possible origin. The resulting antiproton spectrum depends upon whether the material encountered by the primary cosmic-ray protons is mostly inside or outside the regions of acceleration. The relative ratio of antiprotons and protons with $E > 10$ GeV is expected to be about 10^{-4} if the protons have passed through 2 to 3 gm/cm^2. (Diss. Abstr.)

Direct Energy Conversion

Refer also to abstracts 25061 and 25207.

24087 (ANL-7316) GALVANIC CELLS WITH FUSED-SALT ELECTROLYTES. Cairns, E. J.; Crouthamel, C. E.; Fischer, A. K.; Foster, M. S.; Hesson, J. C.; Johnson, C. E.; Shimotake, H.; Tevebaugh, A. D. (Argonne National Lab., Ill.). Nov. 1967. Contract W-31-109-eng-38. 219p. Dep. CFSTI.

The thermally regenerative bimetallic galvanic cells discussed use a relatively volatile liquid-alkali metal having a low electronegativity for the anode, and a relatively nonvolatile liquid metal of high electronegativity for the cathode. The anode metal is oxidized to form a cation which migrates through the fused-salt electrolyte to the cathode, where it is electrochemically reduced, forming an alloy with the cathode metal. The electrons released at the anode travel through the electrical circuit to the cathode. The cathode alloy circulates from the cell to a high-temperature regenerator (1050 to 1600°K), where the anode metal is vaporized away from the cathode metal. The anode metal vapor is condensed

and returned to the anode compartment of the cell, completing the cycle. The process is Carnot-cycle limited. In selecting suitable anode metal–cathode metal pairs, the proper electronegativity differences must be chosen so that the alloy can be separated at reasonable regenerator conditions while still maintaining an appropriate cell voltage (0.5 to 0.7 V). Furthermore, the electrode materials and the electrolyte should melt at low temperatures, and the solubilities of the metal phases in the electrolyte should be minimized. Also, corrosion must be avoided. Of the alkali metals, lithium and sodium exhibit the highest cell emf values and have the best physicochemical properties for use in galvanic cell systems. Therefore, studies were made on cells with sodium and lithium anodes. The studies covered thermodynamics, physicochemical properties, phase relationships, cell systems, and materials stability. The results indicate that very high power densities (3.5 W/cm^2), very high recharge rates, and long continuous regeneration times can be obtained. (D.L.C.)

24088 (DLR-MITT-66-07, pp 31-47) ENTWICKLUNG EINES NUKLEAR BEHEIZTEN THERMIONISCHEN ENERGIE-WANDLERS. (Development of a Nuclear Heated Thermionic Energy Converter). Gross, F.; Jester, A.; Winkenbach, H. (Brown Boveri/Krupp Reaktorbau G.m.b.H., Mannheim (West Germany)). (In German).

A Cs diode with cylindrical Mo emitter and Nb collector was developed. The emitter is filled with nuclear fuel material and tested in the reactor. The element is so constructed that its diode properties can be investigated before its introduction into the reactor by electrical simulation of the nuclear heating of the emitter. Irradiation studies were made on a Mo emitter filled with UO_2 and having the shape of the emitter in the Cs diode. The form behavior of the emitter at operational temperatures was determined with respect to the fission gas pressure, the diffusion of fuel elements and fission products through the emitter material, and the effect of various fuel forms. (J.S.R.)

24089 (DLR-MITT-66-07, pp 49-67) EMITTER MIT CARBIDISCHEM BRENNSTOFF FUER THERMIONISCHE KONVERTER. (An Emitter with Carbide Fuel for a Thermionic Converter). Guenther, R.; Kadner, M.; Poeschel, E.; Rochow, H.; Schuster, K. (Battelle Institut e. V., Frankfurt am Main (West Germany)). (In German).

The characteristics of a fuel element containing a thermionic converter are outlined. It is shown how an emitter with nuclear heater can be constructed fulfilling these characteristics. The dimensions, heat production, utilization and operational time, damage caused by fission products, introduction of coated particles, and selection of the filler and emitter were considered. The output obtainable with coated particles was calculated. (J.S.R.)

24090 (LA-3813) SMALL OUT-OF-PILE THERMIONIC CONVERTER. Frank, Thurman G.; Anderson, Richard C. (Los Alamos Scientific Lab., N. Mex.). Sept. 27, 1967. Contract W-7405-eng-36. 8p. Dep. CFSTI.

The preliminary design of a nominal 10-kW electrical space power supply is presented. The design uses heat pipes together with radiation coupling to transfer heat from a small compact reactor to a converter consisting of a large number of thermionic diodes of planar design. Heat pipes are used to concentrate and to disperse heat flux within individual diodes. Each component of the power supply is conservatively designed, and considerable improvement could be realized from additional study and a modest development program. The unshielded specific weight of the power supply is ~95 lb/kW electrical. (auth)

24091 (NYO-3886-1) IMPROVED COMPATIBLE MATERIALS FOR THERMOELECTRIC POWER GENERATION. Semiannual Report. Dismukes, J. P.; Kudman, I.; Moss, H. (Radio Corp. of America, Princeton, N. J. RCA Labs.). Feb. 1968. Contract AT(30-1)-3886. 45p. Dep. CFSTI.

The first system investigated for improved p-type material was the PbTe–GeTe system, since n-type material in this system was known to give superior properties. A series of alloys containing 1 to 15% GeTe was prepared in this system with various p-type dopants, but upon life testing, the electrical properties were found to be unstable, which could be attributed to an insufficient equilibrium solubility of the dopants. Therefore, work on this system has been terminated. In the next system investigated, PbTe–PbSe, the solubility of sodium was found to be enhanced by the addition of PbSe. The figure of merit of the 95 mole % PbTe–5 mole % PbSe composition doped with a 0.7 mole % Na was found to be 30% greater at elevated temperatures than that of p-type PbTe. Life tests at 400°C have shown no change in resistivity after 2000 hours for 95% PbTe–5% PbSe, but small changes were observed for samples containing 10 and 15% PbSe. Therefore, the 95% PbTe–5% PbSe composition appears to be the optimum. (auth)

24092 SUPPLEMENTARY LOSSES IN MHD CHANNELS OF THE FRAME TYPE. Bolchek, B. B.; Yantovskii, E. I. Izv. Akad. Nauk SSSR, Energ. Transp., No. 1, 142-7(Jan.-Feb. 1968). (In Russian).

The supplementary losses in the frame channel of the MHD generator and accelerator were evaluated. In contrast to works examining the spatial picture of the current in the plane perpendicular to the magnetic field, the boundary problem of the current in the plane formed by the vector of the magnetic field and the channel axis was solved. The specifics of the frame-type channel was shown by the fact that in the presence of the Hall effect the surface of the conducting frame, bordering on the gas current, impedes the Hall emf. Currents and supplementary Joule losses, calculated in the assumption of the homogeneous profile of the velocity and in the absence of the pre-electrode potential drop, were developed. It was shown that during electrode steps, equal to the channel height, and Hall number = 7 the potential losses can comprise 50% of the generated output, and during increase of the channel height by 40 electrode steps, these losses practically disappear. (tr-auth)

24093 MHD TOPPING CYCLES: A REASSESSMENT. Evans, R. K. Power, 112: 65-7(Feb. 1968).

The drawbacks of MHD cycles are reviewed. The idea that MHD electrical power generation may have arrived too late on the scene for extensive commercial exploitation is discussed.. Barring some unforeseen technical breakthrough, two events would have to occur to make MHD appear economically feasible again, namely: (1) high-grade uranium ore reserves proving less than expected, or becoming exhausted before the successful breeder reactor becomes a reality, so forcing higher fuel-cycle costs, and (2) concurrently increasing coal prices. (M.H.R.)

24094 EEI FLUID METAL MHD RESEARCH PROGRAM: FINAL SUMMARY REPORT. EEI (Edison Elec. Inst.) Bull., 35: 426-9; 431(Dec. 1967).

Development of electromagnetic generators for fluid metal magnetohydrodynamic (MHD) power conversion (EEI Research Project RP63-Fluid Metal MHD) is reported. The ultimate application of the generator is in the MHD portion of a binary system composed of a fluid metal MHD topping cycle and a conventional steam plant. The addition of the fluid metal MHD topping cycle offers higher overall plant efficiencies through the use of higher temperatures. This project demonstrated the feasibility of the variable-fluid and variable-field-velocity liquid metal MHD generator. The values of ac power produced were the largest yet generated by MHD means and are capable of being scaled up to outputs of interest in central stations. The results of the generator investigations, when coupled with those independently obtained on the thermokinetics performance of the fluid metal MHD cycle, indicated this approach to be of interest as a means of improving the overall performance of central station plants. Preliminary economic studies were made of 2 types of situations. One is a completely new plant employing a modern steam turbine cycle and an MHD topping cycle with potassium as the working fluid. The second is an existing standby plant upgraded by the addition of a potassium-circulating MHD topping cycle. Maximum temperature for the metal working fluid is 1600°F in both cases. The preliminary engineering estimates indicate that the net cost of power can be made lower, for the new plant and the upgraded plant situations. (BBB)

24095 PERFORMANCE OF SPACE-POWER LIQUID METAL MHD CYCLES UTILIZING A TWO-PHASE FLOW GENERATOR. Petrick, Michael; Roberts, John J. (Argonne National Lab., Ill.). J. Spacecraft Rockets, 4: 967-73(Aug. 1967).

A comprehensive study has been made of two-phase liquid metal MHD generators incorporated in one- and two-component cycles. Included in the analysis is a realistic appraisal of friction losses and two-phase conductivity limitations. The concept of fluid recycle to limit the void fraction within the generator is proposed, and the effect on cycle efficiency is determined. Under the assumptions of this study, the two-component Li–Cs system has a realizable efficiency of 10%, which is higher than has been calculated for other liquid-metal MHD power cycles that have been proposed for space power application. For the one-component cycle, the maximum efficiency that can be demonstrated is 8%. This efficiency is obtained with extensive recycle of the $K_{0.4}$–$Hg_{0.6}$ working fluid. Serious limitations on obtainable voltage and electrical efficiency of liquid metal MHD generators are shown to exist. These are due entirely to cycle considerations and electrical shunt losses. In order to achieve attractive voltage and generator efficiencies, the analysis shows that the electrical end losses must be reduced by at least 80%. (auth)

24096 A UNIFIED THEORETICAL DESCRIPTION OF THERMIONIC CONVERTER PERFORMANCE CHARACTERISTICS. Wil-

kins, D. R. (General Electric Co., Pleasanton, Calif.). J. Appl. Phys., 39: 2452-8(Apr. 1968).

Fundamental principles of molecular chemistry, statistical mechanics, and plasma physics are used to derive theoretical output current and efficiency characteristics of vapor thermionic converters. The results are obtained in terms of basic physical parameters which describe the converter electrodes and interelectrode gas and are in good agreement with corresponding experimental measurements for a broad range of converter operating conditions. The analysis has practical applications for converter physics studies, converter performance evaluations, and thermionic power plant design. (auth)

24097 RECENT DEVELOPMENTS IN THE DIRECT CONVERSION OF HEAT INTO ELECTRICITY BY MEANS OF MAGNETO-HYDRODYNAMIC ELECTRICAL POWER GENERATION. Nowacki, P. J. (Inst. for Nuclear Research, Warsaw). Neue Tech., 10: No. B1, 3-24(Feb. 1968).

The present state of MHD power generation is reviewed. The basic theoretical principles of operation are discussed. (M.O.W.)

24098 GENERATOR OF ELECTRICAL ENERGY. (to Nuclear Materials and Euipment Corp.). British Patent 1,103,084. Feb. 14, 1968. Priority date Dec. 3, 1964, United States.

A generator of electrical power is described which comprises a first thermoelectric means, a heat source in heat-interchange relationship with the first means, a second thermoelectric means, and a heat sink in heat-interchange relationship with said second means. There is a means thermally interconnecting the first and second thermoelectric means and establishing a low thermal impedance path between the first means and the second means. There is also a means connecting the first thermoelectric means and the second thermoelectric means in series in an electrical circuit. (M.H.R.)

24099 COMPOSITE-STRUCTURE ELECTRODE FOR OPEN-CYCLE MAGNETOHYDRODYNAMIC GENERATOR. Yerouchalmi, David (to Commissariat a l'Energie Atomique). British Patent 1,109,962. Apr. 18, 1968. Priority date May 25, 1965, France.

A composite electrode is described which is primarily designed for use in the channel of an MHD converter. The electrode comprises an assembly of plates fabricated of refractory material coated with layers of either noble or inert refractory metals and associated with a water-cooled metal box. (M.H.R.)

Fluid Physics

Refer also to abstracts 24018 and 24144.

24100 FUNDAMENTAL EQUATIONS OF ELECTROMAGNETODYNAMICS OF FLUIDS: VARIOUS CONSEQUENCES. Carstoiu, John (International Consultant Scientists Corp., Brookline, Mass.). Proc. Nat. Acad. Sci., U. S.; 59: 326-31(Feb. 1968).

The problem is analyzed in its generality, paying special attention to the densities of "magnetic current" and "magnetic charge," which seem to play important roles. First, the Maxwell tensor is reformulated in order to take into account the electromagnetic properties of matter, starting with equations formulated earlier by the author (Proc. Nat. Acad. Sci. U. S., 57: 1536-41 (1967)). Thereafter, equations are developed in succession for the following: (1) electrohydrodynamic and magnetohydrodynamic analogies, (2) density of magnetic current, and (3) electrohydrodynamic waves. The macroscopic model built shows how the magnetic charge may be related to matter if the charge exists. (L.M.T.)

24101 THERMAL INSTABILITY OF A MAGNETOFLUID IN A VERTICAL RECTANGULAR CHANNEL. Yu, C. P. (Univ. of Colorado, Boulder). Phys. Fluids, 11: 756-60(Apr. 1968).

The onset of the instability of an incompressible, viscous and electrically conducting fluid heated from below and confined within a vertical, rectangular channel is investigated when a uniform magnetic field is applied normally to one side of the channel. The condition for the stability revealed by the critical Rayleigh number is found to be dependent upon both the Hartmann number which is a measure of the magnetic effect and the aspect ratio of the channel. (auth)

24102 ESTABLISHMENT OF STEADY HYDROMAGNETIC FLOW PAST SLENDER BODIES. Fan, D. N.; Ludford, G. S. S. (Cornell Univ., Ithaca, N. Y.). Phys. Fluids, 11: 747-55(Apr. 1968).

Fan's treatment [Phys. Fluids 10: 1756 (1967)] of the plane flow of a moderately good conductor is here extended to the more realistic axially symmetric case, for two reasons: to substantiate the algebraic decay of the transient motion; and to clear up an apparent contradiction which would have invalidated the perturbation analysis used in both. The magnetic field diffuses in from a solenoid wound round the circular tunnel in which potential flow past the slender body has been set up. The ultimate flow is found to be essentially Lary's steady motion when the tunnel is very wide, thus substantiating the practical relevance of his work. (auth)

24103 PROPAGATION OF ALFVEN WAVES IN A VISCOUS FLUID OF FINITE ELECTRICAL CONDUCTIVITY. el Mohandis, M. G. S. (Ain-Shams Univ., Cairo). Nuovo Cim., 54B: 214-32 (Apr. 11, 1968).

Mathematical solutions for magnetohydrodynamic disturbances and fluid motion are given for the case of a magnetic dipole suddenly introduced in an infinite incompressible viscous fluid of finite electrical conductivity, and placed parallel to the exciting field. Walen's approximation is used and is exhibited as the first term of a series expansion of the exact solution. Another problem is solved where the dipole is kept fixed in the direction of the z coordinate and so placed to be perpendicular to the exciting field, which is considered to be in the x axis. (auth)

24104 MAGNETOHYDRODYNAMIC UNSTEADY FREE CONVECTION. Chawla, Sahib Singh (Indian Inst. of Tech., Kharagpur). Z. Angew. Math. Mech., 47: 499-508(Dec. 1967).

The unsteady free convection flow from an infinite vertical plate, under the action of a transverse magnetic field, is analyzed in the case when the plate temperature undergoes a thermal transient. The solution is obtained by Laplace transform technique. The applied field is found to induce a wave-dominated flow pattern. The flow within the viscous and thermal boundary layers is also considered. At all stages of the motion the shearing stress at the plate is found to be larger than the corresponding value in the nonmagnetic case, although the viscous part is smaller. (auth)

24105 A MAGNETOHYDRODYNAMIC FLOW IN THE SHOCK TUBE BOUNDARY LAYER WITH TRANSVERSE MAGNETIC FIELD. Dukowicz, Janusz Karol. Toronto, Univ. of Toronto, 1966.

Thesis.

Some cases of boundary layer flow in a shock tube with insulated walls and a transverse magnetic field are investigated experimentally and theoretically. The configuration is similar to the insulator boundary layer in an MHD generator channel with a loading parameter equal to unity. With argon as the test gas, the experimental results show some cases where the heat flux to the wall is uninfluenced by the magnetic field, and others where a strong effect is observed. A Couette flow calculation, incorporating all relevant physical phenomena and representing the conditions encountered in the experiment, has been carried out. The results indicate the Hall effect has an important influence in such a way that when Hall currents are unrestricted there is little change in the heat flux. The strong interaction observed may be explained by the absence of Hall currents, or possibly by the occurrence of an electron thermal instability predicted by Kerrebrock at high Hall parameters. (Diss. Abstr.)

24106 NONUNIFORM ELECTRICAL CONDUCTION IN MAGNETOHYDRODYNAMIC CHANNELS. Oliver, David Anthony. Stanford, Calif., Stanford Univ., 1967. 184p.

Thesis.

Methods of describing steady electrical conduction in a partially ionized gas with Hall effect, strong applied or magnetically induced electric fields, nonuniform electrical conductivity, and nonequipartition electron heating are proposed. The occurrence of nonequipartition heating is shown to lead to the possible development of arbitrarily large conductivity gradients in the gas. Nonequipartition heating is also found to lead to a steady-state electrical conduction problem characterized mathematically by a system of partial differential equations of mixed elliptic–hyperbolic type. It has previously been shown that the time-dependent form of the electromagnetic and diffusion equations used in the present work predict an ionization instability which occurs with strong Hall effects. In the present work, the effect of finite rates of ionization and recombination on this ionization instability are examined. It is shown that, in the absence of heat conduction and pressure-gradient-induced diffusion, the condition for the onset of the ionization instability with finite rates is unchanged from that with infinitely fast ionization. The growth time of the instability, however, is proportional to the longer of the ionization time or the energy equipartition time. It is also shown that in this case the condition that the steady equations be uniformly elliptic is identical to the condition for the prevention of the ionization instability. These methods are applied to flowing gases in two-dimensional linear magnetohydrodynamic (MHD) channels with segmented-electrode structures. Detailed numerical solutions for current and potential are obtained. It is found that

low-conductivity layers over the electrodes in the presence of Hall effects cause a more uniform distribution of current on the electrode relative to the uniform-conductivity case. High-conductivity layers, however, cause a more nonuniform current distribution on the electrode. The low-conductivity layer is also shown to lead to a straightening of the current lines in the core of the channel relative to the uniform conductivity case. High-conductivity layers, however, shift the current lines so that in the core of the channel, the current flows at the Hall angle. When nonequipartition heating is allowed to occur with nonuniform Joulean heating, it is found that the Hall potential is decreased relative to the uniform conductivity case. This effect occurs because of increased Joulean heating near the electrode-insulator segments. When the electrons are permitted to be driven out of local equilibrium by finite rates and gas dynamic convection, it is shown theoretically that the current concentrations on one of the electrode walls become less intense while on the opposite wall the current concentrations become more intense. In general, it is found that all types of conductivity nonuniformities considered lead to a degradation of performance of MHD generator channels as reflected in increased internal impedance of the conducting gas and depressed Hall voltage. Calculated distributions of current on electrodes in contact with a layer of low-conductivity gas are shown to be consistent with the results of experiment. The theoretically predicted antisymmetry of current concentrations on electrode walls with finite rate effects is also in accord with reported experimental results. (Diss. Abstr.)

24107 MAGNETOHYDRODYNAMIC SHOCK PRODUCTION AND CURRENT SHEET DIFFUSION. Hoffman, Alan Lowell. Pasadena, Calif., California Inst. of Tech., 1967. 160p.

Thesis.

Current sheets in inverse pinch MHD shock tubes exhibit the strange property of forming shocks in the very rear of the sheet when accelerating heavy gases. When accelerating light gases, shocks are formed further to the front in the sheet, but in no case do the shocks separate from the driving current sheet. This "piston dragging shock" effect is explained on the basis of a single-fluid model with variable conductivity. Shocks are shown to always form within current sheets which move at supersonic speeds with respect to the driven gas. The relevant parameters for determining the shock position are the Mach number and the magnetic Reynolds number. Large magnetic Reynolds numbers and small Mach numbers enhance forward shock formation. These conditions are obtained in light gases with high speeds of sound. Similarity methods are developed to estimate gas conductivities, electron temperatures, and degrees of ionization for the experiments which are conducted. In hydrogen typical electron temperatures of 4 eV are produced by the ohmic heating, but twice this value is shown necessary to achieve separation at the current sheet speeds of 2 to 3 cm/μsec used. Higher current sheet speeds produce shocks in the rear of the current sheet where separation can never occur. The correct method of procedure and the relevant design parameters to achieve separation are given. The success of single-fluid methods in explaining plasma phenomena is especially notable, and these methods can be extended to other similar problems. Based on these methods, multiple-fluid and microscopic effects are easily detectable and can be accounted for. (Diss. Abstr.)

24108 STRUCTURES OF MAGNETOHYDRODYNAMIC SHOCK WAVE. Liu, Chung Kuang. Washington, D. C., Catholic Univ. of America, 1967. 72p.

Thesis.

The structure of the plane magnetohydrodynamic shock wave of a rarefied, fully ionized plasma is studied. Both the shock front and the magnetic field are assumed to be perpendicular to the flow direction. In the undisturbed region, the gas pressure (=nkT) can be comparable to, much smaller or much larger than the magnetic pressure (=$B^2/8\pi$), and also the magnetohydrodynamic Mach number (M^*) can be any value greater than unity. Since the plasma is so rarefied that the mean free path here can not be considered as a relevant scale length for the shock thickness, instead the geometrical mean of the ion and electron Larmor radius is the appropriate one. Under these assumptions, the structure of larger M^* shock wave is solitary wave-like, and that of smaller M^* shock wave can be either oscillatory or monotonic depending on the value of electrical resistivity. (Diss. Abstr.)

24109 EFFECT OF TENSOR CONDUCTIVITY ON CONTINUUM AND COLLISIONLESS MAGNETOGASDYNAMIC FLOWS. Tang, James Yue-tak. Ithaca, N. Y., Cornell Univ., 1967. 70p.

Thesis.

The steady, linearized flow of a compressible, fully ionized gas past thin bodies in the presence of a uniform applied magnetic field aligned with the undisturbed flow is investigated. The electrical conductivity of the fluid is assumed to be tensor in character, and its magnitude such that the magnetic Reynolds number, based on the length of the body, is large. This requirement may be satisfied in two entirely different physical situations: in a dense plasma which is dominated by collisional effects, or in a diffuse collision-free plasma. Both of these cases are considered here. For the first case, the set of continuum magnetogasdynamic equations is appropriate. This set of equations includes the generalized Ohm's law suitable for fully ionized gases, and takes into account the effects of electron pressure gradients and Hall currents. A normal mode analysis is applied to the governing equation and Fourier synthesis is employed to treat a simple thin body. The quantitative results verify the qualitative predictions of previous authors concerning the effect of small but finite resistivity. For the collisionless plasma, the mean free path for particle collisions is very much larger than other dimensions in the problem. In this case, the approximation of treating the plasma as a continuum is obviously improper. In addition, the usual collision mechanism which generates the randomness that allows a description of the system in terms of the ordinary hydrodynamic variables is absent. Thus it would seem that one must go outside the framework of hydrodynamics, i.e., to the Boltzmann equation, for an adequate description of the phenomenon involved. However, by following the approach of Chew, Goldberger and Low, it is possible to derive a set of self-contained hydrodynamic-like equations that form a uniformly consistent set for treating collisionless magnetogasdynamic flows with a strong magnetic field. The nature of the behavior predicted by these equations for the aligned-fields problem is similar to that given by the continuum equations of Sears and Resler. These two systems of equations are compared after the collision time appearing in the continuum equations is made infinite. It is shown that the two systems become identical for certain specialized upstream conditions. The close mathematical relationship that exists between these two systems provides a convenient interpretation of the collisionless equations in terms of the continuum variables. (TSS) (Diss. Abstr.)

Geophysics

Refer also to abstracts 23928, 23929, 23961, and 24085.

24110 (CEA-R-3121) MESURE DIFFERENTIELLE DU CHAMP MAGNETIQUE TERRESTRE PAR RESONANCE MAGNETIQUE NUCLEAIRE. (Differential Measurement of the Earth's Magnetic Field by Nuclear Magnetic Resonance). Robach, Francis (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). 1967. 93p. (In French). Dep.

Thesis. Submitted to Faculte des Sciences, Univ. of Grenoble, France.

NMR transducers using proton dynamic polarization allows one to convert into a phase measurement any variation of the Earth magnetic field. Several versions of the instrument corresponding to various models of NMR transducers exist, which the author analyzes in detail, devoting an important place to the influence of their alignment with respect to the Earth's magnetic field. The sensitivity obtained is of .01 of a gamma over a bandwidth of (0 to 0.1 Hz). This instrument is designed for measuring field gradients in airborne magnetic surveying, for detecting nearly magnetic anomalies, and for distinguishing between near and distant magnetic phenomena. (auth)

24111 TRAVELING IONOSPHERE DISTURBANCE (REVIEW). Gershman, B. N.; Grigor'ev, G. I. (Ukrainian Correspondence Polytechnic Inst., Kharkov). Izv. Vyssh. Ucheb. Zaved., Radiofiz., 11: 5-27(1968). (In Russian).

A brief review is given on the studies of traveling ionospheric disturbances. The methods and basic aspects of traveling disturbances in the ionosphere, the nature of wave processes related to the traveling disturbances and the heterogeneities of electron concentration appearing during intrinsic wave propagation are discussed. 109 references are included. (R.V.J.)

24112 AURORAL BAND DURING THE IQSY. Starkov, G. V.; Fel'dshtein, Ya. I. (Polar Geophysical Inst., Moscow. Inst. of Terrestrial Magnetism, Ionosphere, and Radio-Wave Propagation, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.), 7: 608(1967).

Translated from Geomagn. Aeron., 7: 744(1967).

The instantaneous auroral distribution at high latitudes represents an oval that is eccentric with respect to the geomagnetic pole. The change in the position of the auroral band at various instants of local time during the IGY was investigated previously as a function of the magnetic activity level. The au-

roral band is the latitude interval in which auroras are observed at the zenith. The change in the boundaries of the auroral band at local geomagnetic noon during IQSY is examined. Use is made of photographic observations from 1963 to 1966. (W.D.M.)

24113 RELATIONSHIP BETWEEN E_s AND SPORADIC METEORS. Kolomiets, A. R.; Kasymova, A. G. (Inst. of Geophysics, Kiev). Geomagn. Aeron. (USSR) (Engl. Transl.), 7: 601-2(1967).

Translated from Geomagn. Aeron., 7: 736-7(1967).

Radar observations of meteor activity were carried out at the station in the village of Tripol'ye in 1965 with the antenna pointing to the north; simultaneously, ionospheric soundings were made at Kiev, about 100 km north of the radar installation. The diurnal meteor activity pattern was compared with the PE_s pattern at the middle of each month. The results of the observations were used to construct the relationship $\overline{PE_s} = f(N_{max})$. The character of the relationship obtained confirms the hypothesis of the possible meteoric origin of E_s. (W.D.M.)

24114 DEPENDENCE OF THE MAXIMUM f_0E_s VALUE ON THE LIFETIME OF AN E_s. Ovezgel'dev, O. (Inst. of Terrestrial and Atmospheric Physics, Ashkhabad, USSR). Geomagn. Aeron. (USSR) (Engl. Transl.), 7: 600-1(1967).

Translated from Geomagn. Aeron., 7: 735(1967).

The existence of a linear relationship between f_0E_s and f_bE_s has been demonstrated previously on the basis of data from Ashkhabad. It was of interest to determine the possible relationship between the maximum limiting reflection frequency $(f_0E_s)_{max}$ and the duration of the continuous existence, T_{E_s}, of individual sporadic formations of the ionosphere. Use was made of data obtained at Ashkhabad from a 15-min observation program in 1962. (W.D.M.)

24115 VARIATION IN THE DURATION OF CONTINUOUS REFLECTIONS FROM E_s. Chernysheva, S. P. (Rostov State Univ., Rostov-on-Don, USSR). Geomagn. Aeron. (USSR) (Engl. Transl.), 7: 598-9(1967).

Translated from Geomagn. Aeron., 7: 733-4(1967).

By taking the PE_s values computed with allowance for a given frequency, one can trace the variations in the duration of continuous reflections from E_s. Data from Rostov, Moscow, Ashkhabad, Alma-Ata, Sverdlovsk, and Irkutsk for 1958 through 1964 were used in the analysis. The durations of continuous reflections were analyzed for PE_s values of 50, 75, and 90% for March, June, September, and December for cutoff frequencies of ≥1 and 3 MHz. (W.D.M.)

24116 DETERMINATION OF THE IONIZATION RATE IN THE F2 LAYER. Ivanov-Kholodnyi, G. S.; Kolomiytsev, O. P. (Inst. of Applied Geophysics, Moscow. Inst. of Terrestrial Magnetism, Ionosphere, and Radio-Wave Propagation, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.), 7: 596-8(1967).

Translated from Geomagn. Aeron., 7: 731-2(1967).

Some of the most important problems in the physics of the polar ionosphere, particularly at night, are the characteristics of ionization sources and their distribution and variation as a function of season and solar activity. Some studies have already been made that relate to the lower part of the ionosphere, but the problem is complicated in the F region by the difficulty of accounting for the diffusion effect. One of the possible methods of determining the ionization rate is examined. (W.D.M.)

24117 RELATIONSHIP BETWEEN THE REFLECTION COEFFICIENT AND THE PARAMETERS OF THE FINE STRUCTURE OF THE REFLECTION REGION OF THE F2 LAYER OF THE IONOSPHERE. Shirmammedov, M. (Inst. of Terrestrial and Atmospheric Physics, Ashkhabad, USSR). Geomagn. Aeron. (USSR) (Engl. Transl.), 7: 594-5(1967).

Translated from Geomagn. Aeron., 7: 729-30(1967).

The effect of ionospheric inhomogeneities on the reflection coefficient ρ has been little studied. Therefore, it is of interest to analyze data that were obtained from simultaneous measurements of ρ on three spaced antennas. Such observations of the nighttime F2 layer were made at Ashkhabad and some of the results were previously described. (W.D.M.)

24118 EQUATORIAL ANOMALY OF f_0F2. Mizun, Yu. G. (Polar Geophysical Inst., Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.), 7: 593-4(1967).

Translated from Geomagn. Aeron., 7: 728(1967).

The study of the behavior of the F region at low latitudes during a global magnetic storm leads to the conclusion that the variation of ionization density is determined mainly by the phase and time of commencement of the magnetic storm and by local time. There is no physical sense in averaging the Δf_0F2 variations over several storms that begin at different times of day and in separating the average obtained into a D_{st} and an SD component. Averaging can be performed only for storms that commence at the same time of day. In this case the initial phases of the magnetic storms must have the same duration. (W.D.M.)

24119 HORIZONTAL GRADIENTS OF F2-LAYER CRITICAL FREQUENCY ASSOCIATED WITH LOCAL TIME. Kovalevskaya, E. M. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio-Wave Propagation, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.), 7: 588-90(1967).

Translated from Geomagn. Aeron., 7: 722-4(1967).

The planetary distribution of longitudinal gradients of the F2 layer critical frequency and their variation as a function of the time of day, season, and solar activity was examined. Since the latitudinal variation of ionization is associated chiefly with the zenith angle of the Sun, temporal gradients, computed from critical frequency data of many ionospheric stations located in various longitudinal and latitudinal belts of the Earth, were used to determine the diurnal, seasonal, and other characteristics of critical frequency variation as a function of longitude. (W.D.M.)

24120 CRITICAL FREQUENCIES OF THE UNDISTURBED F2 LAYER IN YEARS OF MAXIMUM SOLAR ACTIVITY. Dolgova, E. I. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio-Wave Propagation, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.), 7: 590-2(1967).

Translated from Geomagn. Aeron., 7: 725-7(1967).

To estimate the zero ionization level of the F2 layer, from which the deviations, $\Delta fF2$, were subsequently determined for the period of disturbances, f_0F2 values on magnetically quiet days were selected. Days were regarded as quiet when the 24-hour sum of the K_p index did not exceed 10 to 15. (W.D.M.)

24121 POLAR CAP ABSORPTION ON FEBRUARY 5, 1965, AND ITS EFFECT ON THE INTENSITY OF IONOSPHERIC SCATTER SIGNALS IN THE ANTARCTIC. Driatskii, V. M. Geomagn. Aeron. (USSR) (Engl. Transl.), 7: 543-5(1967).

Translated from Geomagn. Aeron., 7: 668-71(1967).

The results of an analysis of scientific observations at Vostok Station, Antarctica, were used to study the characteristic features of radio-wave absorption of the polar cap type (PCA), observed on February 5, 1965. Electron density in the absorption region, height above sea level, and collision frequency were determined. The complex character of the influence of PCA on the intensity of radio waves scattered in the ionosphere, which depends on the magnitude of absorption and on the scattering of the ionized layer, was confirmed. (auth)

24122 VERIFICATION OF RELATIONSHIPS FOR ESTIMATING THE ERROR IN PHASE MEASUREMENTS. Bykov, Yu. V.; Mirkotan, S. F. (Moscow State Univ.). Geomagn. Aeron. (USSR) (Engl. Transl.), 7: 538-42(1967).

Translated from Geomagn. Aeron., 7: 662-7(1967).

The results are reported of an experimental verification of the analysis of the influence of reference voltage instability on phase variation measurements. The validity of the relationships used to estimate the error of ionospheric phase installations is verified. (auth)

24123 STRUCTURE OF THE ELECTROMAGNETIC FIELD BEHIND A SCREEN WITH RANDOM INHOMOGENEITIES. Pogorelov, V. I. (Inst. of Atmospheric Physics, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.), 7: 518-26(1967).

Translated from Geomagn. Aeron., 7: 637-47(1967).

Electromagnetic emission that has passed through a layer with random fluctuations of the index of refraction (screen) and has propagated farther into free space is examined. The amplitude characteristics of the field are computed, using a method in the process of which the probability distribution function for the quantity $A_1 A_2$ (A_1 and A_2 are the amplitudes at points r_1 and r_2) are somewhat modified and expanded in cumulants. The fourth cumulant is computed numerically, while higher cumulants are assumed to be equal to zero. The values of $\langle (A_1 A_2)^{2p} \rangle$ are found in this approximation. The solution is exact for $p = 1$ and approximate for $p > 1$. The $\langle (A_1 A_2)^{2p} \rangle$ values for nonintegral p are found by interpolation with respect to p. A phase screen with a logarithmically normal field distribution and with a structural phase function of a type formed by a turbulent medium is examined as an example. (auth)

24124 SPREADING OF MOVING INHOMOGENEITIES IN A MAGNETOACTIVE PLASMA (IONOSPHERE). Gurevich, A. V.; Tsedilina, E. E. (Lebedev Inst. of Physics, Moscow. Inst. of Terrestrial Magnetism, Ionosphere, and Radio-Wave Propagation, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.), 7: 527-32 (1967).

Translated from Geomagn. Aeron., 7: 648-54(1967).

Asymptotic formulas describing the spreading of inhomogeneities were examined. The results of numerical computations de-

scribing the form of spreading and the lifetime of an inhomogeneity are reported. It is shown that an inhomogeneity splits in two with time and the two parts move at substantially different velocities. (auth)

24125 DETERMINATION OF THE DIMENSIONS OF IONOSPHERIC INHOMOGENEITIES FROM THE RECORDS OF THE FADING OF SATELLITE SIGNALS AT TWO FREQUENCIES. Bishof, K. Geomagn. Aeron. (USSR) (Engl. Transl.), 7: 533-7 (1967).

Translated from Geomagn. Aeron., 7: 655-61(1967).

The dimensions of ionospheric inhomogeneities were studied by determining the fading index and by direct determination of the correlation between the records of satellite signal amplitudes at 20 and 40 MHz. The values obtained range from 0.8 to 4 km and apparently increase with increasing magnetic latitude. (auth)

24126 S_D VARIATIONS OF THE GEOMAGNETIC FIELD AT YAKUTSK AND SOLAR ACTIVITY. Danilov, A. A.; Krivoshapkin, B. P.; Morozova, S. O.; Sobolev, A. V. (Inst. of Cosmophysical Investigations and Aeronomy, Novosibirsk, USSR). Geomagn. Aeron. (USSR) (Engl. Transl.), 7: 602-4(1967).

Translated from Geomagn. Aeron., 7: 738-9(1967).

The results of a study of the dependence of S_D variations on solar activity are presented. It is assumed that S_D variations are the integral effect of a large number of baylike or polar geomagnetic disturbances. The mean monthly $S_D(Z)$ at Yakutsk were computed for each month from 1954 to 1963. (W.D.M.)

24127 OBSERVED RELATIONSHIPS BETWEEN THE RATE OF CHANGE OF S_q VARIATIONS OF THE GEOMAGNETIC FIELD AND EARTH CURRENTS. Mikerina, N. V. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio-Wave Propagation, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.), 7: 605-7(1967).

Translated from Geomagn. Aeron., 7: 740-3(1967).

The relationship between Earth currents and geomagnetic field variations has been studied extensively. In some studies the observations of various laboratories were used to compare qualitatively the diurnal pattern of the meridional, E_x, and latitudinal, E_y, components of Earth currents with the curves of the X' and Y' rates of S_q variations of the magnetic field. Although most researchers favor the induction relationship between Earth currents and geomagnetic variations, there is much that is obscure in the manifestation of this relationship. The problem in question is examined. Use was made of observations from 1924 to 1964 at 15 stations where simultaneous magnetic field and Earth current observations were made. (W.D.M.)

24128 WESTWARD AND EQUATORIAL COMPONENTS OF GEOMAGNETIC FIELD DRIFT. Zolotov, I. G. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio-Wave Propagation, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.), 7: 567-71 (1967).

Translated from Geomagn. Aeron., 7: 699-704(1967).

The drift of the geomagnetic field around an axis that does not coincide with the axis of rotation of the Earth was investigated. Formulas were obtained for computing the westward and equatorial drift components which were computed for several epochs. The reality of the existence of an equatorial drift component is demonstrated. (auth)

24129 PROBLEM OF SEPARATING THE GEOMAGNETIC FIELD INTO AN ANOMALOUS AND A NORMAL COMPONENT. Lugovenko, V. N. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio-Wave Propagation, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.), 7: 557-62(1967).

Translated from Geomagn. Aeron., 7: 687-93(1967).

Separation of the observed geomagnetic field into two parts, anomalous and normal, was examined. Physical premises were used to prove the randomness of the anomalous magnetic field with respect to the normal field. The ratio of the spectra of the two parts of the geomagnetic field was analyzed. It follows that a wave with a period of 200 km carries the highest energy in the anomalous field. Use can be made of spherical harmonic analysis for optimal separation of the geomagnetic field into two parts. (auth)

24130 PULSATIONS OF THE PP TYPE AS CHERENKOV RADIATION. Bryunelli, B. E.; Lyatskii, V. B. (Leningrad State Univ.). Geomagn. Aeron. (USSR) (Engl. Transl.), 7: 553-6(1967).

Translated from Geomagn. Aeron., 7: 682-6(1967).

The possible explanation is discussed of pulsations of the PP type as the Cherenkov radiation of a flux of energetic protons passing through a blob in the background plasma at a velocity slightly below Alfvén velocity. An estimate of the energy of Cherenkov radiation shows that selection of reasonable values for the flux parameters makes it possible to explain the formation of pulsations with observed amplitudes. (auth)

24131 MAGNETOSPHERE AND GEOMAGNETIC PULSATIONS. Lyatskii, V. B. (Leningrad State Univ.). Geomagn. Aeron. (USSR) (Engl. Transl.), 7: 550-2(1967).

Translated from Geomagn. Aeron., 7: 677-81(1967).

The possible formation of a standing Alfvén wave in segments of magnetic force tubes bounded on one side by the Earth's surface and on the other side by neutral points at the magnetosphere boundary is discussed. The possible shift of the source region of pearl-type pulsations relative to the equatorial plane in the direction of one of the neutral points is examined. (auth)

24132 VERTICAL DISTRIBUTION OF ELECTRON CONCENTRATION IN THE MAGNETOSPHERE ACCORDING TO WHISTLER DATA. Molchanov, O. A. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio-Wave Propagation, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.), 7: 546-9(1967).

Translated from Geomagn. Aeron., 7: 672-6(1967).

It is shown that it is better to use the two-parameter modification of the gyrofrequency model in determining the vertical distribution of electron concentration in the magnetosphere from whistler data. (auth)

24133 GENERATION OF PLASMA WAVES AND ELECTROMAGNETIC WAVES AND SOME PROBLEMS REGARDING THE TURBULENCE OF PARTICLE FLUXES IN THE GEOMAGNETOSPHERE. Trakhtengerts, T. Yu. (Gorky State Univ., USSR). Geomagn. Aeron. (USSR) (Engl. Transl.), 7: 492-9(1967).

Translated from Geomagn. Aeron., 7: 606-15(1967).

The generation of plasma and electromagnetic waves and the turbulence of particle fluxes in the geomagnetosphere are examined. It is shown that beam instability can be explained by the origin and general properties of ulf emission in the auroral zone. The properties of acceleration mechanisms, acting the magnetosphere, and the energy and intensity of particle fluxes exciting ulf signals can be judged to some extent from the character of ulf emission. Nonlinear effects with which the turbulence of particles fluxes is associated (deceleration, heating, and isotropy) appear at fluxes $S \sim 10^9$ cm^{-2} sec^{-1}. The isotropy of a beam may strongly interfere with the free escape of particles from the geomagnetic trap. The acceleration of some particles to energies substantially exceeding the average particle energy in the beam is possible with beam turbulence. (auth)

24134 INFLUENCE OF A CONSTANT ELECTRIC FIELD ON THE MOTION OF CHARGED PARTICLES IN A DIPOLE MAGNETIC FIELD. Samokhin, M. V. (Radio Engineering Inst., Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.), 7: 486-91(1967).

Translated from Geomagn. Aeron., 7: 598-605(1967).

The two-dimensional problem of Alfvén on the motion of a charged particle in a magnetic field $B_0 + M/r^3$ (where B_0 and M are constants and r is the distance to the axis) and in an electric field E = const, perpendicular to the magnetic field, is extended to the case of a dipole magnetic field with an E = const perpendicular to the moment. The motion of the guiding center, averaged over particle oscillations along lines of force, is examined on the assumption of the existence of two adiabatic invariants, i.e., the magnetic moment and the longitudinal adiabatic invariant. The form and dimension of the forbidden zone and the position of the mirror points are found. It is shown that in this field geometry there is an effect of the ideal focusing of charged particles at some point on the axis crossing the dipole perpendicularly to the intensity vector of the electric field in the equatorial plane. (auth)

24135 RESULTS OF SPACE RESEARCH: THE MAGNETOSPHERE. TRW Space Log, 7: 51-5(Summer 1967).

Satellite data, obtained with magnetometers and radiation detectors, that indicate how the Earth's magnetic field modifies the solar wind are reviewed. In 1963 measurements on the sunward side of the Earth established that the geomagnetic field created a shock wave in the solar wind at a distance of 12 to 14 R_E toward the Sun, the distance varying with the intensity of the wind. Subsequent measurements by spacecraft have considerably refined this concept of the magnetosphere, and the dynamics of the magnetosphere and its complete shape are considerably more accurately understood. Explorer 18 data showed the geocentric distance of the magnetopause to be 10.25 R_E and of the shock wave to be 13.4 R_E at the subsolar point; moreover that the thickness of the magnetopause is about 800 to 5000 km and that the position of the magnetopause depends on the angle of the Earth's dipole magnetic field with respect to the direction of flow of the solar plasma. Measurements by the Vela satellites have shown that the boundaries of the magnetosphere are centered on a line that is 2 to 4° west of the Sun–Earth line, since the solar wind arrives at the Earth at an angle that is preferentially westward. Sometimes the reversal of the field occurs over a relatively narrow space, where the field strength drops to zero, indicating a field-free surface in the tail. At other times multiple changes in the field direction

have been observed, indicating either a complicated configuration of the field or a time-varying configuration of the neutral sheet or both. Radiation measurements by the Velas showed that a thick slab of plasma stretches across the tail centered on the neutral sheet. The plasma sheet near the midnight meridian at a range of about 17 R_E has a thickness of 4 to 6 R_E. The sheet extends outward from the termination of the Van Allen belts on the night side to at least 31 R_E. OGO 3 data revealed a peak in electron density of about 10^9/cm²-sec for energies greater than 610 eV at about 19.5 R_E, and about 12 R_E removed from the center of the neutral sheet. Such large intensities of low-energy electrons at these locations aid the understanding of auroral activities and the topology of the geomagnetic tail. The tail may extend until the solar wind disappears, at distances estimated from 20 to 50 AU (about 10^6 R_E), but other calculations indicate only about 1000 R_E for the extent of the tail. (BBB)

24136 STATIONARY CONVECTION OF A LOW-PRESSURE PLASMA. Alekseeva, L. A. (Moscow State Univ.). Geomagn. Aeron. (USSR) (Engl. Transl.), 7: 481-5(1967).

Translated from Geomagn. Aeron., 7: 592-7(1967).

Convective motions of a low-pressure plasma in a magnetic field were investigated. Allowance was made for the heat and mass exchange of the plasma with the body bounding it. The dimensionless parameters of the originating motions were found and their periodicity was estimated. (auth)

24137 VLF PHASE ANOMALY INDUCED BY A NUCLEAR EXPLOSION. Buckmaster, H. A.; Skirrow, J. D. (Univ. of Calgary, Alberta). Nature (London), 218: 155-6(Apr. 13, 1968).

It has been shown that the effects produced by nuclear explosions in the upper atmosphere are similar to those caused by solar flares. The present communication describes observations made concerning the nuclear explosion at Lop Nor, Sinkiang Province, China, on June 17, 1967. It is conjectured that this was a low-megaton high-altitude explosion. Phase changes in the US standard-frequency broadcast service (60 kHz) were monitored; the apparatus employed and its mode of operation are described. The characteristics of the phase disturbance attributed to the nuclear explosion are summarized in tabular form, and the data obtained are discussed. It is concluded that the observed vlf phase anomaly resulted from enhancement of ionization in the D layer caused by electrons precipitating from a drifting artificial radiation belt formed by the explosion, and was not caused by the decay of prompt neutrons to protons and β rays. Data from other nuclear explosions are also discussed. It has been suggested that the time of onset of any effect due to a nuclear explosion in a function of explosion height and yield. This makes it difficult to estimate the yield using vlf detection techniques without a detailed description of the test conditions. (UK)

24138 ELECTROSTATIC WAVES AND IONIZATION IRREGULARITIES IN THE IONOSPHERE. Kato, Susumu; Hirata, Yasuo (Kyoto Univ.). Rep. Ionosphere Space Res. Jap., 21: 85-106(Sept. 1967).

In a partially ionized plasma immersed in crossed electric and magnetic fields there are six modes of electrostatic waves (or space-charge waves), in transverse propagation to the applied magnetic field. Of these six modes five are damping modes and only one is a growing mode. The wave of this mode travels as fast as the electron drift in low frequencies and also cause a two-stream instability which may explain the equatorial sporadic E. In general, ionospheric field-aligned irregularities are examples of this wave. Since the growth rate diminishes as the square of k, the wave number, and further the group velocity has no dispersion with k in low frequencies, the weak irregularities conserve their shapes during movement. Both cold and hot plasmas are considered. It is noted that growth occurs only when the electron drift exceed the ion thermal velocity by 40% or more. (auth)

24139 EFFECT OF THE STRUCTURE OF THE IONOSPHERE ON pc3 PULSATIONS. PART II. SUDDEN DISTURBANCES. Hruskova, Jaroslava (Geophysical Inst., Prague). Stud. Geophys. Geod., 12: 100-7(1968).

The object of the study was to determine the correlation between SID and the amplification, or damping, of a certain "quasi-stationary oscillatory state of the magnetosphere," denoted by the mean amplitude and period of pc3's during hourly intervals immediately preceding the effect. The investigated data contained 132 cases of sudden ionospheric disturbances recorded between May 19, 1961 and December 31, 1964. (W.D.M.)

24140 TRANSIT OF AN ELECTROMAGNETIC LOW-FREQUENCY DISTURBANCE THROUGH THE LOWER IONOSPHERE. Bochnicek, Josef (Geophysical Inst., Prague). Stud. Geophys. Geod., 12: 91-9(1968).

This paper presents results of a first attempt at determining the amplitude of an electromagnetic disturbance observed at the Earth's surface from the amplitude of the disturbance in the ionospheric E layer, none of the processes occurring during the propagation of a disturbance through an inhomogeneous lower ionosphere being neglected. (W.D.M.)

24141 CATALOGUE OF DISTURBANCES IN IONOSPHERE, GEOMAGNETIC FIELD, FIELD INTENSITY OF RADIO WAVES, COSMIC RAYS, SOLAR PHENOMENA, AND OTHER RELATED PHENOMENA, NO. 51, JULY 7-9, 1966. Rep. Ionosphere Space Res. Jap., 21: 143-72(Sept. 1967).

Observational data are given for the disturbances which took place during the period of July 7-9, 1966. Disturbances of the ionosphere, geomagnetic field, field intensity of radio waves, cosmic radiation, solar phenomena, and other related phenomena are cataloged. (W.D.M.)

24142 FLAPPING MOTIONS OF THE MAGNETOSPHERIC TAIL. Obayshi, Tatsuzo (Tokyo Univ.). Rep. Ionosphere Space Res. Jap., 21: 137-41(Sept. 1967).

The first experimental indication of the flapping motions of the magnetospheric tail was found at the multiple encounters of Explorer 10 with the magnetosphere boundary. Evidence for large fluctuations in hot plasma flux has also been found, suggesting that the magnetospheric tail moves back and forth across its average value. If the observed fluctuations are due to the wagging action of the tail, the time constant of this would correspond to either the time-scale of the solar-wind fluctuations, or else that inherent to the tail itself. Possible causes of the flapping are discussed. (W.D.M.)

24143 INTENSITY DECREASE OF VLF HISS ASSOCIATED WITH THE SC OF SEPTEMBER 3, 1966. Ondoh, Tadanori (Radio Research Labs., Tokyo); Isozaki, Susumu; Ouchi, Eiji. Rep. Ionosphere Space Res. Jap., 21: 132-6(Sept. 1967).

A sudden commencement decrease of vlf hiss intensity at 2 and 5 kHz is reported that was observed at Hiraiso (geomagnetic lat. 26°2N, long. 206°3) on Sept. 3, 1966. (W.D.M.)

24144 PROPAGATION OF HYDROMAGNETIC WAVES UNDER THE ACTION OF THE CORIOLIS FORCE. Sakurai, Kunitomo (Kyoto Univ.). Rep. Ionosphere Space Res. Jap., 21: 107-12(Sept. 1967).

The propagation of hydromagnetic waves is considered under the action of the Coriolis force. When the medium is incompressible, both kinds of hydromagnetic waves are excited. Their phase velocities, V, are given by $V^2 = V_{A,Z}^2/1 \pm (2\Omega_z/\omega)$, where ω, Ωz, and $V_{A,Z}$ are the angular frequency of the wave, the angular velocity of the rotating system, and the Alfvén velocity component along the propagation vector k. These two waves are both circularly polarized, and propagate as being trapped completely by a magnetic line of force. The rotation effect of the phase due to the coupling between the two waves and the exciting mechanism of the waves are considered. (auth)

24145 NEW VAN ALLEN BELT DISCOVERIES DISCLOSED. Strasser, Joel A. Aerosp. Technol., 21: No. 16, 18-20(Jan. 29, 1968).

Three major discoveries recently have produced important new knowledge on the movement and state of electrons in the Van Allen radiation belts. Data collected by the Bell Telephone Laboratories with energetic particle detectors aboard NASA's ATS-1 satellite have revealed the bunching of high-energy outer Van Allen belt electrons as they drift around the Earth in its magnetic field. In another development, Bell Labs' Charles S. Roberts has presented a new theory concluding that radio noise in the charged particle gas surrounding the Earth is responsible for the loss of electrons from the Van Allen belts, rather than the mere presence of lightning-bolt initiated whistlers alone, as previously believed. New satellite data also has led James Van Allén at a recent meeting to suggest that both electrons and protons enter the outer Van Allen radiation belt as a result of being drawn by a high voltage generated across the Earth's magnetic field, caused by the Earth's spin between the dawn and evening sides of the magnetic envelope which surrounds the Earth. The three disclosures represent an important contribution to knowledge of Van Allen belt electron activity, because the data help paint a complete picture, explaining the movement of electrons into and out of the belts, as well as activity of electrons trapped in the belt. The extent to which the new information may affect vehicle and mission considerations for future military and civilian space programs is not certain at this time. (TSS)

24146 HYDROMAGNETIC OSCILLATIONS IN A STRATIFIED ATMOSPHERE. Stepien, K. (Warsaw Univ.). Acta Astron., 17: 31-54(1967).

The problem of hydromagnetic oscillations in an isothermal plasma embedded in a uniform gravity field parallel to a uniform magnetic field is discussed. The presence of the magnetic field causes reflection of the waves, which in turn leads to wave pattern.

When the results are applied to the Sun, it may be seen that the energy trapped in the standing waves should dissipate in the lower solar atmosphere. Certain short-lived phenomena in the solar photosphere and chromosphere can be explained in terms of this effect. (ATD)

24147 NATURE OF THE UPPER ATMOSPHERE. Bhar, J. N. (University Coll. of Science, Calcutta). Sci. Cult. (Calcutta), 33: 312-25(July 1967).

Major phenomena connected with the upper atmosphere are discussed. Information is included on divisions of the atmosphere, the sun and its radiation, tides in the upper atmosphere, ozone and atomic oxygen in the upper atmosphere, the ionosphere, dynamo currents in the upper atmosphere, airglow, and auroras. (TSS)

24148 EMERGENCE AND CERTAIN PECULIARITIES OF THE SPORADIC E LAYER. Samardzhiev, Dimitur. Izv. Geofiz. Inst., Bulg. Akad. Nauk, 8: 31-44(1966). (In Bulgarian).

Certain peculiarities of the sporadic E layer are examined on the basis of data from vertical ionospheric sounding at ten stations located between 40 and 80°N latitude. The diurnal and seasonal variations over a period of one year, as well as the geographical and geomagnetic correlations of the probability of the emergence of of the sporadic layer (PE_s), for layers with frequency $f_0E_s \geq 3$ Mc and the relative number of P_1E_s and P_2E_s for layers with frequencies $f_0E_s \geq 3$ and 5 Mc were investigated. For the medium geographical latitudes, these parameters exhibited well-expressed diurnal and seasonal variations with maximum values near midday and in the summer months. In June, between 06.00 and 18.00 hrs, all the sporadic layers observed had boundary frequencies over 3 Mc. Minimum sporadic activity was observed in the morning and evening hours and in March and November. The diurnal and seasonal variations of the probable emergence of $f_{min} \geq 3$ Mc were studied in the auroral zone (Murmansk station). It was found that the diurnal variation of Pf_{min} has a maximum near midday and a seasonal maximum —in March and September. A negative correlation was established between the diurnal variation of PE_s and Pf_{min} probabilities correlation coefficient $R \simeq -0.80$. The relative P_1E_s and P_2E_s numbers do not show a diurnal or seasonal dependence. The absence of such a dependence shows that in the auroral zone, the solar wave radiation does not have a direct ionizing effect on the formation of a sporadic layer. A geographical dependence of the PE_s probability was also established. The values of PE_s diminish with increasing latitude (in the summer they decrease from 80% for stations situated at about 40°, to 30% for stations located further to the north). On the other hand, the relative P_1E_s and P_2E_s numbers show a well-expressed geomagnetic ratio. Their values at geomagnetic latitudes of 30° and 65 to 70° are considerably higher than those between 45 and 55°. This difference is particularly pronounced during the winter period. The increase in P_1E_s and P_2E_s may be related to the ejection of electron fluxes radiated by the internal and external radiation layers into the atmosphere at these geomagnetic latitudes. (ATD)

24149 NEW INVESTIGATIONS REGARDING VARIATIONS IN THE EARTH'S ELECTROMAGNETIC FIELD AND SUN-PHYSICS DATA, RECURRING AT 27-DAY INTERVALS. Hollo, Lajos; Vero, Jozsef Magy. Geofiz., 7: 157-62(1966). (In Hungarian).

The authors compared data based on velocity readings of telluric currents at the Nagycenk Observatory [Hungary] during 1960–1962 with readings made during 1957–1959. They found a significant change in the degree of correlation. This seemed to confirm that during periods of low solar activity and gradually starting magnetic storms, pulsation shows increasing periodicity. The readings also showed that pulsations which do not depend on magnetic activity have a lesser tendency to recur at 27-day periods. (ATD)

24150 IONOSPHERIC EFFECT OF PENETRATION OF FAST PROTONS INTO THE D-REGION IN THE MEAN GEOMAGNETIC LATITUDES. Letfus, Voytekh; Nestorov, Georgi (Astronomical Inst., Ondrejov, Czechoslovakia). Izv. Geofiz. Inst., Bulg. Akad. Nauk, 8: 11-17(1966). (In Bulgarian).

The effect of the flux of protons on the ionization state of the D region was studied. The flux was generated by a chromospheric solar flare which took place on 4 May 1960. A close correlation was determined between the ionospheric absorption at 27 and 164 kc and the behavior of the energy flow of protons. The ionization effect of solar particles during that occurrence is interpreted by a new mechanism of distribution of these particles over the length of the magnetic energy lines between the Sun and the Earth, the presence of which is indicated by the Forbush effect of the period under study. (ATD)

24151 MAGNETIC STORMS CAUSED BY NUCLEAR EXPLOSIONS. Sajti, Laszlo. Magy. Geofiz., 7: 168-70(1966). (In Hungarian).

Certain disturbances in the Earth's magnetic field which occurred after high-altitude blasts in August and September 1958 (Argus I, II, III) and July 1962 are discussed. The effects of the Johnston Islands nuclear explosions of July 9, 1962 were observed in Hungary. Remarkable similarities were found between the magnetic storm as recorded at La Habra, California and at Tihany, Hungary. An analysis of the recordings at the Tihany Geophysical Observatory is presented. (ATD)

24152 EFFECTIVE ELECTRON COLLISION FREQUENCY IN THE LOWER F REGION OF THE IONOSPHERE. Singh, R. N. (Banaras Hindu Univ., India). Proc. Phys. Soc. (London), 87: 425-8(1966).

Heating of electrons due to additional energy input into the ionosphere has been considered. The electron temperature profiles for various energy inputs into a model ionosphere were calculated. Using temperature profiles thus obtained, the electron collision frequencies were calculated. It is shown that electron–ion collisions are comparable to electron–neutral particle collisions and cannot be ignored in the lower F region. In view of the large positive ion collision cross section and its temperature dependence, the possibility of ionospheric cross modulation of radio cosmic noise is described. (Indian Sci. Abstr.)

24153 IDENTIFICATION OF ACOUSTIC AND GRAVITY-WAVE MODES ASSOCIATED WITH TRAVELLING IONOSPHERIC DISTURBANCES CAUSED BY NUCLEAR EXPLOSIONS. Wickersham, A. F. (Stanford Research Inst., Menlo Park, Calif.). Nature (London), 218: 156-7(Apr. 13, 1968).

It was suggested in 1950 that travelling ionospheric disturbances (TID's) are propagating atmospheric gravity waves. Subsequently quantitative agreement was found between the observed speed distributions of TID's and those expected theoretically for ducted acoustic–gravity waves. Agreement was also found between theory and the observed speeds of TID's caused by an early nuclear detonation; subsequent data from later nuclear tests also showed agreement with theory, and were sufficiently accurate to permit resolution of the fine structure in the acoustic modes—these data are shown in tabular form, and the conclusion is reached that some of the observations are acoustic-like. The remaining data agree well with theoretically predicted speeds of fully ducted gravity modes. (UK)

24154 FURTHER POSSIBLE CONSEQUENCES OF THE ASYMMETRIC DEVELOPMENT OF THE RING CURRENT BELT: EFFECT OF VARIATIONS IN IONOSPHERIC CONDUCTIVITY. Swift, Daniel W. (Univ. of Alaska, College). Planet. Space Sci., 16: 329-42(Mar. 1968).

Numerical calculations of the magnetospheric electrostatic field and ionospheric current field were made assuming that the auroral-zone ionosphere is represented by a ring of enhanced conductivity centered on the geomagnetic pole. These calculations are compared with similar calculations assuming that the ionosphere has a uniform conductivity. For certain ring current particle energies the computation shows that the ring of enhanced ionospheric conductivity results in a near reversal and intensification of the electrostatic field. Intense ionospheric currents are driven along segments of the ionospheric ring. The calculations suggest that the asymmetric ring current may be the responsible agent for driving the auroral electrojet. The results are used to formulate a model of the magnetic substorm associated with the auroral breakup. (auth) (UK)

24155 ELECTRON AND NITROGEN VIBRATIONAL TEMPERATURE IN THE E REGION OF THE IONOSPHERE. Walker, James C. G. (Goddard Space Flight Center, Greenbelt, Md.). Planet. Space Sci., 16: 321-7(Mar. 1968).

There is considerable evidence that electron temperatures in the E region are greater than neutral gas temperatures by several hundred degrees. It is suggested that these temperatures reflect nitrogen temperatures of about 3100°K. Nitrogen vibrational energy may be provided by the reaction which quenches metastable ^1D oxygen atoms produced by photodissociation of oxygen in the Schumann–Runge continuum. Vibrational exchange collisions redistribute the energy, leading to a Boltzmann vibrational distribution for the nitrogen molecules. Vibrational energy is lost mainly in collisions with the ambient electrons, and the lifetime of a vibrating molecule is about 5×10^5 sec in the E region. (auth) (UK)

24156 SEASONAL VARIATIONS IN THE IONOSPHERIC DRIFTS OVER THE MAGNETIC EQUATOR. Deshpande, M. R.; Rastogi, R. G. (Physical Research Lab., Ahmedabad, India). J. Atmos. Terrest. Phys., 30: 319-23(Feb. 1968).

The diurnal and seasonal variations of the N–S and E–W components of drift speeds over the magnetic equator at Thumba during 1964 for E and F regions are discussed. It was found that during Equinox the drift is predominantly westward, whereas

during summer considerable southward component is present in both the regions; during winter a slight northward component is indicated. These deviations from westward direction of the drift are suggested to be due to latitudinal movements of the equatorial electrojet. (auth) (UK)

24157 VIBRATIONAL DEVELOPMENT OF THE NITROGEN SECOND POSITIVE SYSTEM AURORA. Broadfoot, A. Lyle (Kitt Peak National Observatory, Tucson, Ariz.). J. Atmos. Terrest. Phys., 30: 305-7(Feb. 1968).

Measurements of the second positive system (2PG) in aurora were reassessed in a paper by Benesch, Vanderslice, and Tilford (1966), who claim that the new Franck–Condon factors they use are a sufficient improvement on the previously adopted values to justify reinterpretation of the auroral measurements. The present author states that this is not so, close comparison showing that there are no significant differences between the tables used and those used previously for auroral interpretation. The common error of assuming far too much accuracy for the auroral measurements was committed. Also, the importance of the systematic error involved in comparing the measurements of the various observers was overlooked; differences in reported relative intensities can be explained as systematic error, and do not necessarily indicate different vibrational development. (auth) (UK)

24158 EXCITATION OF THE OXYGEN LINES AND IONOSPHERIC HEATING BY CONJUGATE PHOTOELECTRONS. Duboin, M.-L. (Institut d'Astrophysique, Paris); Lejeune, G.; Petit, M.; Weill, G. J. Atmos. Terrest. Phys., 30: 299-304 (Feb. 1968).

Optical observations of the ionosphere above St. Santin de Maurs, made concurrently with Thomson scattering soundings, confirmed that the pre-dawn enhancement of the oxygen red lines in the night airglow occurs in synchronism with electronic heating in the F region at times of sunrise in the magnetically conjugate area. A preliminary calculation indicates that photoelectron impact is directly responsible for excitation of O (^{1}D). (auth) (UK)

24159 SPECTRUM OF GEOMAGNETIC PULSATIONS AT HALLEY BAY. Finlayson, D. M. J. Atmos. Terrest. Phys., 30: 295-8(Feb. 1968).

The spectra of geomagnetic pulsations at Halley Bay indicate dominant periods in the 20 to 40 sec and 150 to 200 sec bands on all days, with a variation in the shorter periods dependent on the K index of magnetic activity. Comparison with results from a comparable observatory in the northern hemisphere indicates that the dominant shorter periods are similar, but that there is no obvious correlation in the times of occurrence. (auth) (UK)

24160 NIGHTTIME F-REGION DRIFTS OVER THUMBA. Deshpande, M. R.; Rastogi, R. G. (Physical Research Lab., Ahmedabad, India). J. Atmos. Terrest. Phys., 30: 293-4(Feb. 1968).

Over Thumba F-region drifts during November and December 1964 were found to be towards the east by night (20.00–23.00 hr) and towards the west by day (11.00–13.00 hr). (auth) (UK)

24161 SOME MEASUREMENTS OF AURORAL ABSORPTION STRUCTURE OVER DISTANCES OF ABOUT 300 KM AND OF ABSORPTION CORRELATION BETWEEN CONJUGATE REGIONS. Ecklund, W. L.; Hargreaves, J. K. (Inst. for Telecommunication Sciences and Aeronomy, Boulder, Colo.). J. Atmos. Terrest. Phys., 30: 265-83(Feb. 1968).

Measurements of auroral absorption were made using a system of five riometers located near Baie St. Paul, P. Q., Canada, (invariant latitude 60°N) and by one riometer at Eights, Antarctica, which is magnetically conjugate to Baie St. Paul. The five-riometer system provided spatial information about the absorption within a radius of about 150 km from the site. Observations with the five-way system showed the absorption increasing steeply to the north, with absorption gradient directed normal to L shells. Typically, the events are more structured to the north, with significant differences in correlation distance observed as a function of latitude and time of day. Some night events appear to move across the site from north to south in a manner which suggests they are diffusing out from a center of activity which usually remains to the north. Evidence for a seasonal change in magnetic conjugacy between Baie St. Paul and Eights is also presented. (auth) (UK)

24162 THEORY OF THE NIGHTTIME F LAYER. Stubbe, Peter (Max-Planck-Institut fuer Aeronomie, Landau/Harz, Ger.). J. Atmos. Terrest. Phys., 30: 243-63(Feb. 1968).

The behaviour of the night-time F-layer, as it appears from the quantities h_m, Y_m, and N_m (height of the F-layer maximum, layer thickness, and maximum electron concentration), can be interpreted by electron losses, ambipolar diffusion, and plasma drifts caused by electric fields in W–E and in N–S direction. The electric fields must be of the order of 5 to 10 V/km, if the loss coefficient and the ambipolar diffusion constant are chosen in accordance with laboratory measurements of the reaction rate for $O^+ + N_2 \rightarrow NO^+ + N$ and of the diffusion cross section for O^+ in O. The theoretical method which gives these results proceeds from the time-dependent continuity equation and the appropriate equations of motion for the electrons, ions, and neutral particles which form a system of coupled partial differential equations. This system is solved numerically by means of a computer. (auth) (UK)

24163 TEMPERATURE DEPENDENCE OF THE REACTION RATE COEFFICIENTS OF O^+ IONS WITH MOLECULAR OXYGEN AND NITROGEN. Smith, D.; Fouracre, R. A. (Univ. of Birmingham, Eng.). Planet. Space Sci., 16: 243-52(Feb. 1968).

Measurements of the rate coefficient, k_0, for the reaction of O^+ ions with O_2 molecules were made over the temperature range 185 to 576°K. Assuming a power law dependence, this dependence may be written in the form: $(3.4 \pm 0.5) \times 10^{-10}\ T^{-(0.48 \pm 0.05)}$ cm^3 sec^{-1}. This suggests a possible dependence of k_0 on the inverse square root of the temperature. A comparison is made with results obtained from drift tube and photo-ionization source measurements, as well as with estimates of k_0 made from ionospheric data. The temperature dependence of the rate coefficient, k_N, for the reaction of O^+ ions with N_2 molecules has not yet been established due to experimental difficulties. Preliminary measurements indicate that only a small change in k_N is to be expected over the temperature range of the experiments. (auth) (UK)

24164 RESPONSE OF THE UPPER ATMOSPHERIC TEMPERATURE TO CHANGES IN SOLAR EUV RADIATION AND GEOMAGNETIC ACTIVITY. Chandra, S.; Krishnamurthy, B. V. (Goddard Space Flight Center, Greenbelt, Md.). Planet. Space Sci., 16: 231-42(Feb. 1968).

The upper atmospheric neutral temperature derived from satellite drag was analyzed with a view to determining the relative importance of solar euv and magnetic activity on heating of the upper atmosphere. As indices of solar euv radiation the radio fluxes obtained from the ground based observations in the frequency range of 200 to 9400 Mc were used. For the period March 7–May 15, 1962, a direct comparison was also made with the euv flux obtained from the OSO 1 Satellite. As the index of magnetic activity the planetary magnetic index K_p was used. The data were analyzed by separating the long-period components of 27 days and above from the short-term components by using a 5-day running mean filter. A cross correlation study between the various parameters shows that the long-term variations in temperature are strongly correlated with the similar variations in the radio flux in the frequency range 1000 to 3750 Mc, the correlation being a maximum at 1000 Mc. The short-term variations in temperature, on the other hand, are strongly correlated with those in ΣK_p, the daily sum of K_p indices, and not with the radio flux at any of the frequencies considered. The correlation between temperature and euv flux in the short-term components is somewhat better, though not as striking as the long-term components. An empirical relation between temperature and the changes in radio fluxes and ΣK_p based on the above correlation study shows that

$$T_N = 524 + 2.73\ \bar{S}_{10.7} + 1.77\ (\Sigma K_p - \overline{\Sigma K_p})$$

or $$T_N = 470 + 6.53\ \bar{S}_{30} + 1.77\ (\Sigma K_p - \overline{\Sigma K_p})$$

where T_N is the nighttime minimum temperature; and $\bar{S}_{10.7}$, $\bar{S}_{30}$ and $\overline{\Sigma K_p}$ are the 5-day running means of 2800-Mc radio flux, 1000-Mc radio flux, and ΣK_p respectively. The present investigation leads to the conclusion that short term variations in temperature are closely associated with the changes in magnetic activity represented by K_p and all the systematic variations in temperature, including the so called semiannual variation can be fully accounted for in terms of the similar variations in solar flux. (auth) (UK)

24165 MEASUREMENTS OF THE THICKNESSES OF AURORAL STRUCTURES. Maggs, J. E.; Davis, T. N. (Univ. of Alaska, College). Planet. Space Sci., 16: 205-9(Feb. 1968).

Using an image orthicon television system measurements were made of the thicknesses of 581 auroral structures appearing in the magnetic zenith over College, Alaska, during 5 nights in 1966 and 1967. Assuming a lower border height of 100 km for all structures, the thickness values ranged from the instrumental limit at 70 m to 4440 m, the median thickness being 230 m. Rayed auroral structures were found to be thinner than homogeneous structures, and all types exhibited a strong tendency to become thinner as their brightness increased. (auth) (UK)

24166 VARIATIONS IN THE WIDTH OF THE O I λ5577 LINE IN THE NIGHT AIRGLOW. Armstrong, E. B. (CSIRO, Camden, New South Wales). Planet. Space Sci., 16: 211-29 (Feb. 1968).

Measurements of the width of the O I λ5577 line made at night with a Fabry–Perot interferometer are presented and the observed variations discussed. It is shown that one type of variation was associated with relatively small magnetic disturbances. Another type was apparently due to the rapid recombination in the F region in the evening, but the observations were not sufficiently numerous to make this a certainty. A third and rarer type was not properly explained. All these types are believed to have been caused by λ5577 emission from above 200 km. A fourth type was almost certainly due to a temperature variation in the region emitting the green line by the Chapman process, and this variation appeared to be seasonal, coinciding in phase with the seasonal variation of the green line intensity. Some preliminary attempts to detect a Doppler shift due to wind in the 90 to 100 km region are briefly described. (auth) (UK)

24167 INITIAL INTERACTION BETWEEN THE SOLAR WIND AND ANY LARGE OBSTACLE. Beard, David B. (Imperial Coll. of Science and Tech., London). Planet. Space Sci., 16: 145-57 (Feb, 1968).

Particle trajectories are examined for the case where the solar wind containing a weak interplanetary magnetic field is incident on an obstacle whose radius of curvature is much larger than the proton gyroradius in the interplanetary field (~500 km). It is shown that even in the absence of thermal and dissipative effects, a discontinuity in field and particle velocity will arise and that the electrons will share the solar wind energy in a scale length of a few kilometers. Further physical implications of Dungey's analysis of the solar wind–magnetic field boundary are obtained and the analysis is extended to the case where the charge separation electric field is absent, as it might be in a steady state where the electric fields are shorted out by electrons travelling along the magnetic field (e.g., to and from the ionosphere) [Dungey, J. W., Cosmic Electrodynamics, pp. 132-58(1958)]. Thermal and dissipative effects are discussed briefly to illustrate how the co-ordinated behaviour of a smooth surface with a cold steady plasma disappears in the longer scale length in which a shock front of magnetohydrodynamic waves thermalizes the plasma. (auth) (UK)

24168 NEW TECHNIQUE FOR MEASURING ELECTRON TEMPERATURE IN THE IONOSPHERE. Wilson, J. W. G.; Garside, G. (Univ. of Birmingham, Eng.). Planet. Space Sci., 16: 257-72(Mar. 1968).

The technique used is an extension of Langmuir probe principles. Two identical probes, separated in potential by a small voltage ΔV, explore the exponential current–voltage characteristic by means of a voltage sweep which has a small 6-kHz signal superimposed on it. The resulting 6-kHz differential currents to the two probes are monitored and adjusted to a pre-determined ratio by altering ΔV. The electron temperature can then be readily obtained, as it is simply related to the known ratio and the voltage between the probes. Analysis of the characteristic results in a single measurement which yields electron temperature directly, thus providing a method of rapid determination. Considerations applicable to the servo control loop used are discussed, as is also the expected accuracy of the system. Improvements in the technique which eliminate a possible source of error are outlined thus resulting in a highly accurate determination of electron temperature. (auth) (UK)

24169 SOME HORIZONTALLY-MOVING IONOSPHERIC IRREGULARITIES AT HIGH LATITUDES. Goodwin, G. L. (Univ. of Queensland, Brisbane). Planet. Space Sci., 16: 273-83(Mar. 1968).

Two large-scale horizontally moving "frontal" ionospheric irregularities were identified on bottom-side ionograms recorded at several stations separated by distances ~1000 km at high northern latitudes. Each irregularity appeared as a vertical set of horizontally moving echoes at height intervals of approximately 11 km from 111 to 165 km. The echoes were considered to be produced by interference among the members of a train of internal gravity waves reflected at a height of about 170 km at a negative scale-height gradient. Horizontal and vertical wavelengths of the internal gravity wave-motion were 800 km and ~13 km, respectively, and the periodicity was 7.6 hr. It appears that "troughs" of ionization density (recorded on topside ionograms) and the present irregularities were manifestations of the same set of travelling ionospheric disturbances, which were apparently produced by a train of internal gravity waves whose horizontal motion originated in the vicinity of the North Geomagnetic Pole. The irregularities were produced at a time of enhanced ionospheric absorption indicative of increased geomagnetic activity. (auth) (UK)

24170 NIGHT SKY PHOTOMETRY OF [O I] λ5577 AND λ6300 INSIDE THE SOUTHERN AURORAL ZONE. Gordon, M. A. (Massachusetts Inst. of Tech., Lexington). Planet. Space Sci., 16: 297–308(Mar. 1968).

Observations of [O I] λ5577 and λ6300 emissions on a 6-min time scale at Cape Hallett, Antarctica, during the austral winter of 1961 are described. The 67 days of data, taken by a self-calibrating zenith photometer of 5° field of view, show a seasonal decrease and pronounced diurnal maximum for both emissions. The intensity distributions were highly skewed for both emissions, with the mode, mean, and average of λ5577 being 525, 725, and 975 R, respectively; and of λ6300, 375, 475, and 600 R. Power spectra analyses of emission intensities as time series show that, for periods less than 0.5 hr, both λ5577 and λ6300 data can be described by a first order linear Markov process with correlation coefficients of 0.7 and 0.1, respectively. The λ5577 and λ6300 intensities vary independently of each other on a time scale of minutes, but not on a time scale of hours. For both emissions, the rate of change, as well as level, of emission intensity shows no apparent correlation with local magnetic activity. (auth) (UK)

24171 TRANSPORT OF FLARE PLASMA FROM THE SUN TO THE EARTH. Hirshberg, Joan (Ames Research Center, Moffett Field, Calif.). Planet. Space Sci., 16: 309-19(Mar. 1968).

The shape of the shock front produced in the solar wind by the plasma from highly geo-effective solar events was determined. This shape is based on an analysis of data on the size of the sudden commencements of geomagnetic storms. The analysis was made on the basis of gas dynamics. It is found that the flare plasma expands on a broad front, but with considerable departure from Sun-centered radial symmetry. The implications of these results to theories of flare plasma production and geomagnetic storm processes are discussed. (auth) (UK)

24172 NORTH–SOUTH ASYMMETRY IN STORM TIME VARIATION OF f_0F2. Rajaram, Girija; Rastogi, R. G. (Physical Research Lab., Ahmedabad, India). J. Atmos. Terrest. Phys., 30: 651-3(Apr. 1968).

A study of Dst (f_0F2) variations at equatorial and subtropical stations at different longitude zones for 1951–1956 shows that at equatorial stations in any of the zones the variations indicate an increase of f_0F2 during the main phase. The northern subtropical stations in any of the zones indicate a decrease of f_0F2 during the main phase. The southern subtropical stations show decreased f_0F2 for Asian and African zones, but at American and Pacific zones an increase of f_0F2 during main phase of the storm is noted. (auth) (UK)

24173 SPORADIC-E CLASSIFICATION FROM ROCKET MEASUREMENTS. Rao, M. Mukunda; Smith, L. G. (Univ. of Illinois, Urbana). J. Atmos. Terrest. Phys., 30: 645-50(Apr. 1968).

During the NASA mobile launch expedition, when rocket experiments were conducted at various latitudes, the presence of various types of sporadic E was noticed on the corresponding ionograms. Careful examination of data from a d-c probe showed that irregularities of ionization having spatial periods of approximately 75 to 270 m, with amplitudes greater than 10% of the ambient density, existed whenever diffuse nonblanketing sporadic E was present. Such irregularities were also noticed during equatorial launching (close to the magnetic equator) in the altitude range 90 to 100 km, with an amplitude of about 12%. It is suggested that these irregularities are responsible for the equatorial E_s or q-type E_s reflection seen in the ionograms. It appears that irregularities closer to the E-region peak, having larger amplitudes and smaller spatial periods, are more effective in producing this nonblanketing type of sporadic E. Of the various sporadic-E parameters, fbE_s rather than fE_s is a better measure of the peak electron density in the ledges of ionization appearing in the E region. These observations suggest the existence of two types of E_s; one consisting of overdense ledges of ionization and the other of underdense irregularities of ionization. (auth) (UK)

24174 LONG-LASTING STORM EFFECTS IN THE IONOSPHERIC D REGION. King, J. W.; Fooks, J. L. (Radio and Space Research Station, Slough, Eng.). J. Atmos. Terrest. Phys., 30: 639-43(Apr, 1968).

A study of data recorded after eighteen magnetic storms indicates that the amplitude of the 245 kHz signals from Kalundborg (56°N, 11°E) received over distances of the order of 600 km show storm after effects which lasted for up to 8 days. The after effects during the early evening persisted longer and were more

pronounced than those at 23.00 L.M.T. The amplitude received over a path to the north of Kalundborg was always decreased during the storm after effect, but this was not always the case for a path south of Kalundborg. The most pronounced effects over the southern path occurred 1 day later than over the northern path. Some evidence is given which indicates that the fading rate of the signal was also affected during the week after a storm. (auth) (UK)

24175 LUNAR PERTURBATION OF THE CRITICAL FREQUENCY OF THE F2 LAYER AT LOW LATITUDES. Rush, C. M.; Venkateswaran, S. V. (Univ. of California, Los Angeles). J. Atmos. Terrest. Phys., 30: 633-8(Apr. 1968).

The semidiurnal lunar perturbation of the critical frequency of the F2 layer was determined for a number of low-latitude stations from data collected during the IGY–IGC and IQSY periods. It is shown that the phase of the perturbation changes with height at a rate of 2–4 hr/100 km during solar maximum and 5–6 hr/100 km during solar minimum in the height range 250 to 500 km. (auth) (UK)

24176 COUPLING EFFECTS BETWEEN THE IONOSPHERE AND STRATOSPHERE IN CANADA (45°N, 75°W), 1962–1966. Manson, Alan H. (Univ. of Canterbury, Christchurch, New Zealand). J. Atmos. Terrest. Phys., 30: 627-32(Apr. 1968).

A superposed epoch analysis applied to results obtained in Canada has shown a significant correlation between stratospheric warmings on the one hand, and ionospheric and geomagnetic observations on the other. (auth) (UK)

24177 STUDIES OF RESONANCES AND OTHER PHENOMENA ON THE FIXED-FREQUENCY TOPSIDE SOUNDER RECORDS. King, J. W.; Hawkins, G. L.; Rix, H. G. (Radio and Space Research Station, Slough, Eng.). J. Atmos. Terrest. Phys., 30: 621-6(Apr. 1968).

Examples of resonances at the second, fourth, and fifth harmonic of the electron gyro-frequency observed on Explorer 20 (fixed-frequency topside sounder) records are described. The resonances are found to possess a very complicated structure and to exhibit a marked variation in amplitude as the angle between the satellite antennae and the Earth's magnetic field lines changes. There appears to be a critical value of this angle at which the character of the gyro-resonance effect alters. Examples are also given of records which illustrate the phenomena occurring when the X and the O echoes are returned from zero virtual depth. (auth) (UK)

24178 SIMULTANEOUS BALLOON MEASUREMENTS OF AURORAL X RAYS DURING SLOWLY VARYING IONOSPHERIC ABSORPTION EVENTS. Bewersdorff, A. (Laboratoire de Physique Cosmique, Meudon, France); Kremser, G.; Stadsnes, J.; Trefali, H.; Ullaland, S. J. Atmos. Terrest. Phys., 30: 591-607 (Apr. 1968).

The results are reported of measurements made in northern Scandinavia. It was found that during typical events the electron precipitation starts north of L = 6.5 and spreads southwards to at least L ≈ 4.5 with speeds of about 500 m/s. The events apparently have a large longitudinal extension, with the southern border aligned almost geomagnetically east–west. After the expansion, the electron precipitation appears to decay uniformly over the area which was covered during the expanding phase. Faster pulsations were often observed, superimposed on the general trend of the events, and microbursts are probably always present. (auth) (UK)

24179 THERMAL STRUCTURE OF THE TEMPERATE-LATITUDE IONOSPHERE. Evans, J. V.; Mantas, G. P. (Univ. of Illinois, Urbana). J. Atmos. Terrest. Phys., 30: 563-77(Apr. 1968).

Previous theoretical attempts to explain the altitude variation of electron and ion temperature in the ionosphere at temperate latitudes are reviewed. New model calculations are presented, which include all known important physical processes, with the possible exception of ion conduction. The relative importance of the solar uv heat input and heat conducted from the protonosphere in controlling the electron temperature profile is investigated by varying these two parameters. Attempts are made to match published electron temperature profiles obtained at Millstone Hill (Massachusetts) in 1964 and St. Santin (France) in 1966. In this work the observed electron density profile is employed in the calculations and appropriate neutral densities and temperatures were taken from the Harris and Priester (1962) atmosphere models. Fairly good agreement can be obtained for the Millstone results when the solar uv heat input is reduced to about one third the value estimated by Dalgarno et al. (1963), and when the protonospheric heat flux is raised to ~5 × 10^9 eV/cm²/sec, that is, an order of magnitude higher than some earlier estimates (Geisler and Bowhill, 1965). (auth) (UK)

24180 ELECTRON TEMPERATURES IN THE IONOSPHERIC F REGION OVER AHMEDABAD. Degaonkar, S. S.; Abdu, M. A. (Physical Research Lab., Ahmedabad, India). J. Atmos. Terrest. Phys., 30: 555-62(Apr. 1968).

The electron temperature in the F region was deduced from the derived F-region component of absorption of cosmic radio noise at 25 MHz in high sunspot year (1957–1958) and 21.3 MHz in low sunspot year (1964–65). It is shown that the diurnal and seasonal variations of electron temperature obtained from the analysis are in good agreement with in situ measurement of electron temperature by satellites. (auth) (UK)

24181 SUPERIMPOSED ELECTRIC FIELDS AND THE ADIABATIC INVARIANTS OF MOTION. Catchpoole, J. R. (Univ. of Queensland, Brisbane). J. Atmos. Terrest. Phys., 30: 547-54 (Apr. 1968).

When a longitudinal electric field is superimposed in the direction of the magnetic lines of the Earth's field there is a displacement in the spiraling–mirroring domain of the trapped electrons. Some earlier results on displacement of spiraling electrons by a superimposed electric field are expressed in terms of the adiabatic invariants of charged-particle motion. (auth) (UK)

24182 ELECTRIC FIELDS IN THE AURORA. Bullen, J. M. (DSIR, Christchurch, New Zealand). J. Atmos. Terrest. Phys., 30: 527-36(Apr. 1968).

Night-time ionograms, recording enhanced E at Campbell Island (dip 75.5°S), gave information on physical conditions at auroral heights. Ion density, energy flux, and electron flux at the maxima of the layers, all vary linearly with atmospheric pressure. The semi-thickness of the enhanced E layer is one scale height. The analysis considers only the overhead conditions, and ionograms showing oblique and sporadic-E echoes in addition to the overhead trace were rejected; similarly, records near times of ionospheric absorption were eliminated. Amplitudes and directions of electric fields are estimated from conductivity and current at E-region heights. Electron density profiles of the enhanced E region and conductivities per electron give the integrated conductivities, and the total current is deduced from geomagnetic data. The amplitudes of the electric fields are sensitive to the model atmosphere chosen, especially for heights above 120 km. Directions indicate they are mainly polarization fields. When instabilities of the Farley type are present, the polarization is in the opposite sense from the main sample and the amplitudes are significantly lower. The apparent reduction in field amplitude is more likely to be a change in conductivity pattern than an actual decrease in electric field size. (auth) (UK)

24183 TOTAL IONOSPHERIC ELECTRON CONTENT AT MIDDLE LATITUDES DURING SUNSPOT MINIMUM. Nelson, G. J. (Univ. of Sydney). J. Atmos. Terrest. Phys., 30: 513-26(Apr. 1968).

A technique is described which allows values of total ionospheric electron content deduced from recordings of Faraday rotation rate, made on a single frequency, to be corrected for the effects of N–S gradients. Results obtained by the use of this technique are presented for three stations situated at middle latitudes of the southern hemisphere. Some of these results are compared with corresponding results obtained from the more accurate technique which makes use of dispersive Faraday rotation. This comparison indicates that systematic errors due to gradients can be virtually eliminated by the technique and shows that in the case considered the remaining random errors have a spread of about ±8%. For daytime results the spread is only ±5½%. The ionospheric electron content at midday was observed to be on the average 1.5 times larger in summer than in winter. At night the electron content decays towards a constant value of about 0.3 × 10^{17} electrons/m³, rather than towards zero. There is also a suggestion in a few cases of a minor peak in electron content around midnight. The observing stations differed only slightly in latitude, but in general an increase of electron content towards the equator was observed. Results from satellites observed at Sydney are combined with results from ionosondes to give values of ion temperatures near the peak of the F2 layer. At night temperatures as low as 550°K are observed in winter, and as low as 675°K in summer. The maximum daytime temperatures are 775°K in winter and 1000°K in summer. (auth) (UK)

24184 LUNI-SOLAR TIDAL OSCILLATIONS IN HORIZONTAL MAGNETIC INTENSITY H AND IN f_0F2 AT HUANCAYO DURING LOW SOLAR ACTIVITY PERIOD. Rastogi, R. G. (Physical Research Lab., Ahmedabad, India). J. Atmos. Terrest. Phys., 30: 497-512(Apr. 1968).

Lunar daily and lunar monthly oscillations in f_0F2 and H at Huancayo for the period 1951–1955 are described. Chapman's

Phase Law $L = \Sigma_{n=1}^{4} c_n \sin\{n\tau + (n-2)\nu + \alpha_n\}$ for H is shown to be valid for f_0F2 also. The average phase difference between lunar daily oscillations in f_0F2 and H is 165° for the first and 140° for the second harmonic. The lunar semimonthly tide in H starts increasing with sunrise and is maximum around noon, while the tide in f_0F2 starts increasing about 2 hr after sunrise and has a broad maximum from 10.00 to 16.00 hr. The maximum deviation due to lunar semidiurnal or semimonthly tide averaged over the whole year occurs at about 8 local hr for H and at about 4 local hr for f_0F2. The lunar tides in H or f_0F2 are strongest during December Solstices and weakest during June Solstices. (auth) (UK)

24185 ASSOCIATION BETWEEN ULF GEOMAGNETIC FLUCTUATIONS AND DOPPLER IONOSPHERIC OBSERVATIONS. Duffus, H. J.; Boyd, G. M. (Canadian Services Coll., Victoria, British Columbia). J. Atmos. Terrest. Phys., 30: 481-96(Apr. 1968).

Published studies of ionospheric motions directly associated with geomagnetic variations have postulated three different models of the mechanism by which the interaction occurs. All the models predict relative amplitudes which agree with the observations within a few orders of magnitude, and their authors were unable to choose between them with any degree of certainty. The purpose of the present communication is to report some new observations, and to discuss their bearing upon the three models. It is concluded that only one of the mechanisms is ordinarily compatible with the data, i.e. interaction with hydromagnetic waves at a height where the velocity of the waves is influenced by the ion–neutral particle collision frequency. The data and theory suggest that the interaction between the ionosphere and the fluctuating geomagnetic field which gives rise to the observed Doppler shifts at 2.7 and 4.6 MHz usually occurs in the daytime at heights between 135 and 300 km, and somewhat lower down at night. During the daytime the hydromagnetic EM mode of propagation may be the left circularly polarized mode propagating parallel to the geomagnetic field. At night, however, and particularly in the case of Pt disturbances, the evidence supports the hypothesis that the principal hydromagnetic mode of propagation is the E–O, fast HM, or modified Alfvén wave, propagating perpendicular to the geomagnetic field. There is also experimental evidence that this is not the only mechanism which may be involved in the association between rapid magnetic variations and ionospheric perturbations. In particular, infrasonic waves perturbing, or produced by, electrojet currents appear to be observed on occasion. (auth) (UK)

24186 IONOSPHERIC PREDICTION SYSTEM BASED ON THE INDEX IF2. Smith, P. A. (Radio and Space Research Station, Slough, Eng.). J. Atmos. Terrest. Phys., 30: 177-85(Feb. 1968).

A system based on the index IF2 was developed to predict the propagation conditions for high-frequency radio waves travelling via the F2, F1 and E layers. The physical principles of the system are described. All assumptions made are justified by reference to statistical evidence or published results. Errors affecting each stage of the system are considered and their magnitude is assessed; the overall accuracy is better than that estimated for other systems. (auth) (UK)

24187 IONOSPHERIC DRIFT MEASUREMENT BY A STATISTICAL METHOD. Datta, R. N. (Inst. of Radio Physics and Electronics, Calcutta). J. Atmos. Terrest. Phys., 30: 187-94 (Feb. 1968).

An improvement on the statistical method of analysis for a quick measurement of ionospheric wind parameters for isotropic patterns is suggested. It is found that Pütter's method of analysis, extended by Banerji in presence of random velocities gives different orders of magnitude of true and random velocities and of the direction of the wind velocities with different groups of time delays. Results indicate that the statistical method of analysis rejecting the higher values of timelags, together with the similar fade method of analysis for finding the direction of wind flow, may be expected to give values of V, V_c and θ, the wind parameters for an isotropic pattern, approximating to those of the correlation method without undertaking a lengthy computation process. (auth) (UK)

24188 EAST–WEST MOVEMENTS OF PULSATING AURORAL-ZONE X-RAY EVENTS. Bronstad, K.; Trefall, H. (Univ. of Bergen). J. Atmos. Terrest. Phys., 30: 205-12(Feb. 1968).

During simultaneous recordings by means of balloon-borne x-ray detectors, two cases of pulsating auroral-zone electron precipitation events were observed, moving from east to west along the auroral zone. Both events were observed between 07.00 and 09.00 hr L.T. They moved with velocities of 120 and 150 km/min, and had periods of 300 and 500 sec, corresponding to wavelengths of about 600 and 1250 km, respectively. Both events were superimposed upon the commencement phase of a more slowly varying electron precipitation event, and seemed to represent modulation effects by some travelling hydromagnetic wave upon the main precipitation event. (auth) (UK)

24189 EFFECT OF LONGITUDINAL ELECTROSTATIC FIELD ON THE WHISTLER MODE PROPAGATION IN A WARM MAGNETO-IONIC MEDIUM. Hsieh, H. C. (Univ. of Michigan, Ann Arbor). J. Atmos. Terrest. Phys., 30: 213-26(Feb. 1968).

The dispersion equation for a whistler mode propagation in a warm plasma, subjected to parallel static electric and magnetic fields, is derived by using a linearized coupled Vlasov–Maxwell equation. From the derived dispersion equation the amplitude constant α and phase constant β of the whistler mode are expressed in terms of static electric field E_0, static magnetic field B_0, the electron number density N_0, the electron temperature, and the wave angular frequency ω. The effect of a weak static electric field on the propagation of a whistler mode is investigated in detail; the whistler mode may be amplified or attenuated according to whether E_0 and B_0 are in the same direction or in the opposite direction. The spatial rate of change of the wave amplitude and phase velocity of the whistler mode increase with $|E_0|$ in general. For a low-frequency wave propagation, α is directly proportional to E_0, ω, and N_0, and inversely proportional to B_0^3. A whistler mode propagation in the magnetosphere is also considered. The results of the study show that the effects of a static electric field on the propagation characteristic of a whistler mode are likely to be more important in the region of low geomagnetic latitude and high altitude rather than in the high latitude region. (auth) (UK)

24190 LOW-LATITUDE NEGATIVE BAYS. Akasofu, S.-I.; Meng, C.-I. (Univ. of Alaska, College). J. Atmos. Terrest. Phys., 30: 227-41(Feb. 1968).

It is shown that the eastward current flowing along the auroral zone in the afternoon sector does not generate the westward return current in the middle and low latitudes, but spreads to the equator. It is shown also that the so-called "negative bay" which had been thought to be due to the westward return current is caused by the simultaneous growth of the asymmetric storm-time radiation belt (the ring current). The study suggests a very close relationship between the auroral substorm, the polar magnetic substorm, and the formation of the storm-time radiation belt (the ring current). (auth) (UK)

24191 ELECTRON DENSITY MEASUREMENTS IN THE LOWER IONOSPHERE BY A ROCKET-BORNE RADIO PROPAGATION METHOD. Larson, Lee Edward. Durham, N. H., Univ. of New Hampshire, 1967. 146p.

Thesis.

Results are reported from a series of rocket flights whose primary purpose was to determine the electron density of the lower ionosphere. In addition, on two flights, solar radiation fluxes at 2 to 12 and 1216 to 1450 A were measured. Preliminary to the experimental study, a review of pertinent aspects of the theory of ionospheric formation is presented. The electron density instrumentation was designed to determine the Faraday rotation of linearly polarized waves at 1.005 and 3.385 MHz which were sent from ground-based transmitters to receivers in the rocket payload. The ultraviolet radiation experiment consisted of suitable photoionization chambers coupled with a current-to-voltage amplifier, and a Geiger tube was used to detect the 2 to 12 A x rays. This instrumentation is described in detail. Electron collision frequencies for use in the computation of electron densities are derived from the measured attentuation of the 1216-A solar flux by the atmosphere. The generalized Appleton–Hartree (Sen–Wyller) equation is used for all computations of electron density from the Faraday rotation data. Electron densities are found over an altitude range of 60 to 104 km and under ideal conditions the experiment is sensitive from 40 to 10^5 electrons/cm^3. On two flights the direction of the Faraday rotation reversed at a low altitude. This prompted a study of the generalized Appleton–Hartree equation, from which it is shown that under certain conditions a reversal can take place, and that the collision frequency can be uniquely determined at the altitude where the reversal occurs. These conditions are not satisfied on the two flights and it is suggested that possibly a time change of the electron density profile was responsible for the observed rotation reversal. For two flights the electron densities were computed using solar fluxes measured by the author and recent reports from the literature of atmospheric constituent densities, recombination coefficients, and ionization cross-sections. Comparison of calculated and measured electron density profiles for one flight made during quiet solar conditions indicate that the 1216 A flux acting on NO is sufficient to account for the bulk of the daytime D region. Identical calculations for a flight during a solar disturbance show, as expected, that this process is not sufficient. (Disser. Abstr.)

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Refer also to abstract 24505.

24192 (CEA-R-3157) ETUDE EXPERIMENTALE DE LA SUPRACONDUCTIVITE INDUITE PAR EFFETS DE PROXIMITE. (Experimental Study of Superconductivity Induced by Proximity Effects). Martinet, Alexis (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Dec. 1967. 79p. (In French). Dep.

Thesis. Submitted to Faculte des Sciences, Univ. of Paris, Orsay, France.

A study is presented of the proximity effects between a superconductor (InBi or PbBi alloys) and a "normal" metal (Zn or Sn respectively, above their critical temperature) using essentially the tunneling techniques. On the N side, some specific properties of such an induced superconductivity are described: linear variation of the pair potential near the critical temperature of the binary layer, T_{CNS}; reduced energy scale at T_{CNS}; evidence of a thermodynamic critical field (called Breakdown field) presented by N above its critical temperature. On the S side, crossing from a gapless to a quasi-gapless regime is studied. This gives a proof of a finite coherence length at T_{CNS}. Experimental details (in particular about the preparation and measurement of tunneling junctions) are given in an appendix. Possible applications are suggested. (auth)

24193 (LA-DC-8457) PHENOMENOLOGICAL THEORY OF LIQUID HELIUM II. Mohling, Franz (Los Alamos Scientific Lab., N. Mex.). [1966]. Contract W-7405-eng-36. 76p. Dep. CFSTI.

A phenomenological theory of liquid helium II, similar to Landau's theory of a Fermi liquid, is proposed. The form of the theory and of the quasi-particle energy–momentum relations is deduced from a perturbation theory based on the Bogolyubov transformation. The presence of both negative energy, $\epsilon_-(p)$, quasi particles and positive energy $\epsilon_+(p)$ quasi particles (measured with respect to the chemical potential), with $\epsilon_-(p) = -\epsilon_+(-p)$, is an important feature of the theory, as is the macroscopic occupation of one single-particle state (Bose–Einstein condensation). The two-fluid model of helium II appears naturally, as does Landau's theory of the normal fluid, i.e., the "gas" of elementary excitations. The description of the superfluid by a macroscopic wave function is shown to arise in the theory, provided that a normal fluid–superfluid coupling energy is small. An approximate expression for the superfluid wave function is shown to yield the Onsager–Feynman vorticity quantization condition. It is suggested that in experiments which measure the density of the normal fluid, the inertias of the positive and negative energy quasi particles tend to cancel, and in fact it is this cancellation which yields Landau-like results. The possibility of experimentally verifying at very low temperatures that the measured normal fluid density differs slightly from $\rho - \rho_s$ is proposed. (auth)

24194 (LA-DC-9163) FLOWRATE LIMITS IMPOSED BY THERMAL STRESSES IN STAINLESS STEEL PIPELINES COOLED WITH LIQUID HYDROGEN. Novak, Jan K. (Los Alamos Scientific Lab., N. Mex.). [1967]. Contract W-7405-eng-36. 21p. (CONF-680505-1). Dep. CFSTI.

From 2nd International Cryogenic Engineering Conference, Brighton, England.

A relationship was developed between cooldown flowrate and thermal stress, thus permitting selection of upper flowrate limits to keep the thermal stresses within safe limits. (M.O.W.)

24195 (LA-DC-9200) INFLUENCE OF ACCIDENTS IN THE CONTINUING DEVELOPMENT OF CRYOGENIC PROCEDURES. Reider, Roy (Los Alamos Scientific Lab., N. Mex.). [1967]. Contract W-7405-eng-36. 17p. (CONF-680505-2). Dep. CFSTI.

From 2nd International Cryogenic Engineering Conference, Brighton, England.

Several accidents that have occurred from handling, storing, or purging cryogenic fluids are reviewed, and the appropriate safety precautions are briefly outlined. (TSS)

24196 (NP-17413) NEW GREEN FUNCTION TECHNIQUES IN QUANTUM MANY-BODY THEORY. Lectures given at Bedford College, University of London. Bhagavan, M. R. (Nordisk Institut for Teoretisk Atomfysik, Copenhagen (Denmark)). 1967. 141p. Dep.

A study is made of the Green function techniques devised recently. Restriction is made to system of many fermions, although the developed formalism can easily be adapted to many-boson systems. The analysis is performed for a translationally invariant system of uniform density at absolute zero temperature. The prescription for extending it to nonzero temperatures is given. Some of the well-known formal properties of the one- and two-body Green functions, including the Green function description of the concept of the Landau quasi-particle, are recapitulated. Also the method of Edwards et al. is discussed. (J.F.P.)

24197 FEATURES OF CRITICAL CURRENT BEHAVIOR IN WIRES OF SUPERCONDUCTING NIOBIUM-BASE ALLOYS, AS DEPENDENT ON MAGNETIC FIELD AND TEMPERATURE. Lazarev, B. G.; Lazareva, L. S.; Goridov, S. I. (Physico-Technical Inst., Kiev). Dokl. Akad. Nauk SSSR, 177: 1310-12 (Dec. 21, 1967). (In Russian).

Peculiar features of critical current behavior of superconducting wire in a solenoid were studied at 4.2 and 2°K using Nb–Ti and Nb–Zr–Ti wires. The critical current as a function of magnetic field strength at 4.2 and 2°K, measured as wire specimens and as solenoids with fields up to ~9000 Oe, is analyzed. (R.V.J.)

24198 A 1.3-M HIGH-FIELD HELMHOLTZ COIL WITH FORCED HELIUM COOLING. Brechna, H. (Stanford Linear Accelerator Center, Calif.). Bull. Ass. Suisse Elec., 58: 910-17(Sept. 10, 1967). (In German).

Experiments made with several hard superconductors (type II), cables, and superconducting wave guides are described. The effect of transverse section of the superconductors, electric field characteristics, the behavior of cables and conductors in the transverse magnetic field, and stable behavior of superconducting magnets are discussed. A Helmholtz coil (70 kG) with an interior diameter of 30 cm is under construction at Stanford; it shows a field energy of 6×10^6 J. The transition from the superconducting state to the normal state, perturbations, and corrections to the perturbations are discussed. New conductor configurations and new winding arrangements are presented. A blast electromagnet with water-cooled wave guides will soon be converted into a superconducting magnet so that the central field will be raised from its present level of 20 kG to at least 60 kG. (BBB)

24199 MAGNETIC HYSTERESIS OF SUPERCONDUCTING ALLOYS OF THE Nb-Sn SYSTEM. Potapov, N. N. (Central Scientific-Research Inst. of Non-Ferrous Metals, Moscow). Fiz. Metal. Metalloved., 24: 1012-15(Dec. 1967). (In Russian).

Magnetic hysteresis of Nb–Sn alloys in the region of stoichiometric ratio of sintered Nb_3Sn alloys was studied at 4.2°K in a magnetic field with the intensity from 0 to 12 kOe. Data obtained showed that the magnetic hysteresis of the Nb–Sn alloys cooled in a magnetic field depended on the diameter of the specimen. An increase of the diameter from 2.5 to 5 mm results in an increase of 1.4 to 1.5 times the maximum magnetic energy $(BH)_{max}$ with a smaller (~10%) increase of residual magnetic induction B_r. The dependence of the B_r and $(BH)_{max}$ on the cooling field H_0 in the range from 0 to 12 kOe is close to linear. The data produced a qualitative picture of the influence exerted by magnetic cooling on the hysteresis of strong superconductors and explained the character of the revealed dependence of B_r and $(BH)_{max}$ on H_0. (R.V.J.)

24200 AN AUTOMATED EVAPORATION APPARATUS FOR THE PREPARATION OF SUPERCONDUCTING LAYERS. Dietrich, I.; Gabler, H.; Zerbst, H. (Forschungslaboratorium, Munich). Thin Solid Films (Amsterdam), 1: 203-12(Nov. 1967). (In German).

A metal evaporator with a 16-position mask changer is described. Its volume is 0.5 m^3; in one evacuation cycle, 20 substrates 100 mm × 100 mm can be produced to give 14 layers of different geometry and material. The entire evaporation process may be controlled electronically, with programming by punched tapes. A sequence of layers to illustrate the utility of the device for construction of superconductors is demonstrated: Pb, Pb, SiO, Sn, SiO, Pb, Pb, SiO, Pb, Pb. Layers requiring temperature control are the Sn layer at −50°C and the SiO layers at room temperature. The time required to adjust the temperature is from 10 to 14 min; however, the actual deposition of the superconducting layers requires from 2 to 6 min. The programming sequence for this particular construction of a semiconductor is illustrated. (BBB)

24201 MIXED-STATE HALL EFFECT IN AN EXTREME TYPE-II SUPERCONDUCTOR. Hake, R. R. (North American Rockwell Corp., Thousand Oaks, Calif.). Phys. Rev., 168: 442-4 (Apr. 10, 1968).

Measurements of mixed-state transverse and longitudinal voltages at T = 1.2°K, 0 < H < 39 kG, 0 < J < 800 A/cm^2 on an extremely high-κ type-II alloy superconductor Ti–16 at. % Mo (κ = 68, T_c = 4.2°K, zero-temperature upper critical field H_{c20} = 63 kG) show that the high-J, nearly J-independent, mixed-state Hall-angle tangent $\tan\theta_m(H)$ is much larger than the normal-state value $\tan\theta_n(H)$. At the highest applied magnetic field, the reduced Hall-angle tangent $P_m(H/H_{c20} = 0.35) = [\tan\theta_m(H = 39\ kG)]/[\tan\theta_n(H_{c20})] \approx 0.6$, where H_{c20} = 111 kG is determined by the measured reduced

flux-flow resistivity $\rho_f(H)/\rho_n = H/H_{c2}$. This contrasts with previous results pertinent to pure or low-κ materials where $H_{c50} \approx H_{c2}$: $P_m(0.35) \approx 0.35$ (Bardeen–Stephen theory), 1 (Nozières–Vinen theory), 0.35 (Nb measurements of Fiory and Serin), 2 (Nb–Ta measurements of Niessen et al.). (auth)

24202 STUDY OF THE SUPERCONDUCTIVITY OF THE INTERMETALLIC COMPOUNDS U_6Mn, U_6Fe, U_6Co, AND U_6Ni AND ALLOYS FORMED BETWEEN THEM. Hill, H. H.; Matthias, B. T. (Los Alamos Scientific Lab., N. Mex.). Contract W-7405-eng-36. Phys. Rev., 168: 464-74(Apr. 10, 1968). (LA-DC-9174).

Alloys were prepared between the superconducting compounds U_6X, where X = Mn, Fe, Co, and Ni, to provide a continuous variation in the average electron concentration per atom of the X component of the compounds. Alloys between the X elements themselves are ferromagnetic, and a correlation is found between the superconducting transition temperature T_c of the pseudobinary $U_6(X_i, X_j)$ and the ferromagnetic saturation magnetization per atom σ_M of the pure-element alloy (X_i, X_j). T_c for the compound U_6Ni is reported as (0.41 ± 0.02)°K. (auth)

24203 LOW-TEMPERATURE SPECIFIC HEATS OF Zr–Ti, Zr–Hf, AND Zr–Sc ALLOYS. Betterton, J. O. Jr.; Scarbrough, J. O. (Oak Ridge National Lab., Tenn.). Phys. Rev., 168: 715-25(Apr. 15, 1968).

The specific heats of hexagonal Zr–Ti, Zr–Hf, and Zr–Sc alloys were measured at 1.1 to 4.2°K. Maxima in both the electronic specific-heat coefficient γ and the superconducting transition temperature T_c were observed at 60 at. % Ti in the Zr–Ti system. No superconductivity was found in the Zr–Sc system, although γ rose to high values for pure scandium, and a minimum in γ occurred near 10 at. % Sc. In the Zr–Hf system γ was nearly linear between pure element values. The Debye temperatures Θ_D, after correction for atomic mass and volume, deviate negatively near 60 at. % Ti in Ti–Zr, positively near hafnium in Zr–Hf, and in an S-type manner in Zr–Sc. The effects of scandium in depressing γ in the zirconium-rich region are in qualitative agreement with dependence on electron/atom ratio indicated by earlier B-subgroup solute effects in zirconium-rich alloys. The γ for Zr–Sc alloys, after a correction for phonon enhancement and with the assumption of a rigid band in the alloys, correlates fairly well with the electronic density of states for pure zirconium, calculated by Loucks. The rigid-band approximation, on the other hand, cannot explain the maxima in γ and T_c in Zr–Ti alloys, which involve no change of electron/atom ratio. Rather the maximum may arise from differences in the relative energies of the third and fourth bands in titanium and zirconium, with a crossing of these bands in the alloys. The γ and T_c are related to both the density of states and the electron–electron interactions, and although a clear separation of the two factors is not possible, a reasonable interpretation can be made, assuming that the electron–phonon interaction is nearly constant. (auth)

24204 THERMAL EXPANSION AND MAGNETOSTRICTION OF La METAL AT LOW TEMPERATURES. Andres, K. (Bell Telephone Labs., Murray Hill, N. J.). Phys. Rev., 168: 708-14 (Apr. 15, 1968).

The thermal expansion of fcc La metal has been measured between 1.5 and 40°K. Below 37°K, the linear expansion coefficient in the normal state is found to be negative, with a minimum of -0.95×10^{-6}°K^{-1} at 18°K. This is in contrast with earlier measurements, which were in error. In the superconducting state below 5.59°K, this coefficient is positive, and the extrapolated volume difference $(V_n - V_s)/V_s$ at 0°K is 2.1×10^{-6}. By means of thermodynamics, the volume effects on the electronic specific heat and on the transition temperature are computed. In agreement with recent results of Smith et al., it is deduced that T_c increases under pressure, and it is shown that this increase can be understood as being due to an increase of the density of states at the Fermi surface. (auth)

24205 EFFECT OF A SUPERCONDUCTING SCREEN ON THE RELATIVE STABILITY OF THE BLOCH AND NEEL WALLS IN A FERROMAGNETIC FILM. Dobrosavlevic, Ljiljana (Faculte des Sciences, Orsay, France). Compt. Rend., Ser. A and B, 266: 42-4(Jan. 8, 1968). (In French).

In the presence of a superconducting screen, the magnetic energy of a wall of thickness Δ is augmented by a term $c\Delta^2$ (where c is the same for the Bloch and Neel walls) for the films of thickness D so that the ratio Δ/D is close to unity. It is this region which is of most interest since it is there that the transition from one type of wall to the other is made. It was found that the stability regions of the two types of wall can be little modified by the presence of a screen. (tr-auth)

24206 FIELD DEPENDENCE OF THE RATE OF DECAY OF PERSISTENT CURRENTS IN AN Nb-25 PERCENT Zr SUPERCONDUCTING SOLENOID. File, J. (Princeton Univ., N. J.). J. Appl. Phys., 39: 2335-8(Apr. 1968).

The decay of the magnetic field produced by a persistent current flowing in a superconducting solenoid wound with Nb–25% Zr conductor has been measured at various values of the self-induced magnetic field. The field was varied through the range of 7 to 832 G below the critical field. The results of these experimental runs indicate that over this range of values of the field, the logarithm of the decay rate varies linearly with the field. An estimate of the size of a flux bundle can be made from the result and is 5×10^{-6} cm. (auth)

24207 SUPERCONDUCTIVITY IN EVAPORATED TUNGSTEN FILMS. Basavaiah, S.; Pollack, S. R. (Univ. of Pennsylvania, Philadelphia). Appl. Phys. Lett., 12: 259-60(Apr. 15, 1968).

Tungsten films were found to be superconducting at 3.2°K. Upon investigation by x-ray and electron diffraction, a β-tungsten (A15) structure was evident. Superconducting tunneling studies revealed that the ratio $2\Delta(0)/kT_c$ varied from 2.32 and 3.64 and $\Delta(T)/\Delta(0)$ vs T/T_c followed the BCS theory. (auth)

24208 CURRENT–VOLTAGE CHARACTERISTICS OF JOSEPHSON JUNCTIONS. Stewart, W. C. (RCA Labs., Princeton, N. J.). Appl. Phys. Lett., 12: 277-80(Apr. 15, 1968).

A model for superconducting Josephson junctions analogous to the driven simple pendulum with damping gives dc I–V curves displaying hysteresis for light damping. Excess current and negative dynamic resistance can be obtained with heavy damping. (auth)

24209 ANOMALOUS SUPERCONDUCTING PROPERTIES OF CARBIDES AND NITRIDES OF GROUP IVa AND Va ELEMENTS. Giorgi, A. L.; Szklarz, E. G.; Wallace, T. C. (Los Alamos Scientific Lab., N. Mex.). Proc. Brit. Ceramic Soc., No. 10, 183-94(Mar. 1968).

The variation of the superconducting transition temperature (T_c) of the fcc (NaCl-type) phase of NbC, TaC, HfN, and (Hf, Zr)N solid solution was studied as a function of composition over the homogeneity range of the various compounds. In all cases T_c was found to vary sharply with stoichiometry. For NbC and TaC changes in T_c ranged from a condition of no superconducting transition, for measurements down to 1.05°K for the lowest carbon content, to T_c values of 9.7°K for $TaC_{0.987}$ and 11.1°K for $NbC_{0.977}$. An opposite behavior was observed in the Hf–N system. The highest T_c, 8.7°K, was obtained for the lower stoichiometry and no superconducting transition was found above 2.0°K for the composition $HfN_{1.12}$. The transition temperature for the (Hf,Zr)N solid solution series increased smoothly as the composition became richer in zirconium and reached its maximum value of 10.7°K for $ZrN_{0.943}$. When T_c is plotted as a function of the lattice parameter the resulting curves are similar for all materials studied. T_c increases smoothly with increasing lattice parameter. (auth) (UK)

24210 FIELD DEPENDENCE OF THE SUPERCONDUCTING PROPERTIES INDUCED BY PROXIMITY EFFECTS: BREAKDOWN FIELDS. Phys. Kondens. Mater., 6: 307-24(Oct. 27, 1967).

The properties of S/N (superconducting, normal) binary layers in zero field, especially near their critical temperature T_{cNS}, are discussed. It is shown that the proximity-effect-induced superconductivity in the normal part N of a superconductor/normal metal binary layer (such as In Bi/Zn) can screen a magnetic field up to a critical field H_b. At H_b, a sharp penetration of flux into N occurs. However, the breakdown field H_b can only be observed for certain values of the thickness of N and of temperature. The domain of existence of H_b was examined as a function of these 2 parameters. It was also shown that studies on H_b may yield information on the properties of the pair potential in N. Thus, measurements of H_b performed at the critical temperature of N confirmed the theoretical predictions concerning the behavior of the order parameter in N at this temperature. (BBB)

24211 CHANGE OF GINZBURG–LANDAU PARAMETER UNDER PRESSURE. Fischer, E.; Olsen, J. L. (Swiss Federal Inst. of Tech., Zurich). Phys. Lett., 26A: 387-8(Mar. 11, 1968).

The Ginzburg-Landau parameter κ is changed by pressure. For an indium–thallium alloy with 14% Tl and $\kappa = 0.82$, it is found that $\partial\kappa/\partial p = -4.6 \pm 2 \times 10^{-12}$ cm^2/dyn. (auth)

24212 TUNNELING FROM In FILMS WITH SUPERCONDUCTIVE AND FERROMAGNETIC OVERLAYS. Tomasch, W. J. (Atomics International, Canoga Park, Calif.). Phys. Lett., 26A: 379-80(Mar. 11, 1968).

Effects of remote Al, Pb and Ni overlays on quasi-particle resonances in thick superconductive In films are described. (auth)

24213 CRITICAL TEMPERATURE OF TWO-BAND SUPERCONDUCTORS. Rainer, D. (Siemens AG, Erlangen, Ger.). Solid State Commun., 6: 111-12(Feb. 1968).

Using most general (q,ω)-dependent interband interactions and most general one-particle Green's functions, it is shown that the transition temperature of a two-band superconductor is always raised by the interband coupling. (auth)

24214 ELECTRON–PHONON COUPLING AND PHONON SPECTRA IN LEAD–THALLIUM ALLOYS STUDIED BY ELECTRON TUNNELLING. Claeson, T.; Grimvall, G. (Chalmers Univ. of Tech., Gothenburg, Sweden). J. Phys. Chem. Solids, 29: 387-97(Feb. 1968).

Electron tunneling into superconducting fcc lead–thallium alloys was carried out in the homogeneity range 0 to 70 at. % Tl in Pb. The half energy gap, Δ_0, decreases from 1.35 MeV for Pb to 0.5 MeV for $Pb_{0.3}Tl_{0.7}$. The ratio $2\Delta_0/kT_c$ is reduced from the strong-coupling value of 4.4 to the weak-coupling value 3.5 at about 60 at. % Tl. The anisotropy in the energy gap remains up to about 15% Tl in Pb. A diminishing deviation of the experimental dI/dV vs. V curve from the BCS curve, a lower T_c with higher Tl content, shifts with phonon frequencies, and trends in published neutron-diffraction data show that the electron–phonon coupling decreases with the number of valence electrons per atom. The phonon induced structure in the tunneling curves agree well with phonon spectra from neutron-diffraction work by Stedman et al. and Ng and Brockhouse. The longitudinal peak is shifted towards higher frequencies as the coupling grows weaker. The frequency band of transverse modes broadens as the number of free electrons decreases. A theoretical model was tried to account for the changes in the transverse phonon branches. It was possible to get a qualitative agreement, but the result was unreasonably sensitive to small changes in the form of the pseudopotential or the electron screening. (auth) (UK)

24215 HELIUM ISOTOPE REFRIGERATION. Betts, David S. (Univ. of Sussex, Eng.). Contemp. Phys., 9: 97-114(Mar. 1968).

The recent development of the helium isotope refrigerator, using mixtures of the two isotopes of helium, is probably the most important step forward in the technique of producing low temperatures since adiabatic demagnetization. An attempt is made to describe the special properties of $^3He-^4He$ mixtures, and to show how these properties are used to produce refrigeration below 0.1°K. Design details of actual refrigerators are given, and the direction of future improvements is suggested by a consideration of simple models of the various refrigerator components. (auth)

24216 INFLUENCE OF PLANAR DEFECTS ON SUPERCONDUCTING SURFACE NUCLEATION FIELDS. Tilley, D. R. (Mullard Research Labs., Redhill, Eng.). J. Phys., C, 1: 293-8 (Apr. 1968).

A recent paper by Boyd calculates the superconducting nucleation field of a planar defect such as a grain boundary. Boyd's calculation is extended to the case of two parallel planar defects. Nucleation fields higher than the surface nucleation field H_{c3} can appear; it is suggested that this result is relevant to the explanation of measurements of anomalous surface nucleation fields in cold rolled foils, and of anomalous supercooling fields in thin films. (auth)

24217 INFLUENCE OF DEFECTS ON THE STRUCTURE OF THE INTERMEDIATE STATE IN SUPERCONDUCTIVE LEAD. Sarma, N. V.; Moon, J. R. (International Research and Development Co. Ltd., Newcastle upon Tyne, Eng.). Phil. Mag., 17: 501-8(Mar. 1968).

The intermediate-state structure of superconductive lead at 4.2°K was studied by a refined Bitter technique. The results suggest that the distribution of magnetic flux in 99.99% pure lead is influenced by groups of dislocations formed by mechanical deformation and subsequent room temperature annealing. Nonuniform distributions of impurities and second phase particles appear to influence the recrystallization structures, giving rise to nonuniform distributions of dislocations, and thus have an indirect influence on the intermediate-state structure. (auth)

24218 NONLINEAR RESISTIVITY AND DISSIPATION IN THE MIXED STATE OF SUPERCONDUCTING Nb AND V. Wasim, S. M.; Zebouni, N. H. (Louisiana State Univ., Baton Rouge). Solid State Commun., 6: 69-71(Feb. 1968). (ORO–3087-29).

At high reduced temperatures and low transport current densities, in the mixed state of superconducting niobium and vanadium, a nonlinear behavior of the resistivity and the associated heat dissipation is observed. The I–V characteristic is found to obey a power law. The dependence of the power on magnetic field strength and temperature was investigated. (auth)

24219 ORIGIN OF THE DISCREPANCY BETWEEN TUNNELING AND NEUTRON-DERIVED PHONON DENSITIES OF STATES IN LEAD. Dynes, R. C.; Carbotte, J. P.; Woll, E. J. Jr. (McMaster Univ., Hamilton, Ont.). Solid State Commun., 6: 101-5 (Feb. 1968).

A comparison is presented of the density of phonon states derived from neutron scattering data with that extracted from superconducting tunneling experiments for the case of lead. Calculation of the electron–phonon coupling function $\alpha^2(\omega)$ using a pseudo potential formalism with neutron-derived phonon polarization vectors indicates that this function cannot be responsible for the observed discrepancies. The obvious discrepancies are found to be associated with Van Hove singularities calculated for phonon wave vectors in off-symmetry directions. These are attributed to inaccuracy of the force constant model of the lattice dynamics in predicting off-symmetry properties. (auth) (UK)

24220 SUPERCONDUCTIVITY IN METALS WITH INCOMPLETE INNER SHELLS. Frohlich, H. (Univ. of Liverpool). J. Phys., C, 1: 544-8(Apr. 1968).

Through screening by outer (s) electrons the plasma oscillations of inner (d) bands are transformed into an acoustic phonon branch if certain conditions are fulfilled. Similar to the lattice–phonon branch this provides an interaction with free electrons which leads to superconductivity. Dependence of the transition temperature T_c on the number of (d) electrons follows Matthias' rule. Suggestions for increasing T_c are discussed. (auth)

24221 SUPERCONDUCTIVITY AND THE MAGNITUDE OF ELECTRON–PHONON INTERACTION. Roberts, A. P.; Jones, P. L.; Smith, P. V. (Monash Univ., Australia). J. Phys., C, 1: 548-9(Apr. 1968).

It is shown that the electron–phonon coupling constant in narrow bands is much smaller than in wide bands. The contribution of incomplete (d) bands of transition metals to the total phonon-induced electron interaction, relevant for superconductivity, is much smaller, therefore, than generally believed. (auth)

24222 SUPERCONDUCTIVITY IN $SrTiO_3$. Klose, W. (Univ., Saarbruecken, Ger.); Schuster, H. Solid State Commun., 6: 89-91(Feb. 1968).

The behavior of T_c (n) for $SrTiO_3$ is calculated by a model proposed by Appel. (Phys. Rev. Lett. 17: 1045(1966)). The Eliashberg gap equations are solved numerically for $E_F < \omega_c$. E_F is Fermi energy and ω_c is maximum long. optical phonon frequency. (auth)

24223 SUPERCONDUCTIVITY OF LANTHANUM INTERMETALLIC COMPOUNDS WITH THE Cu_3Au STRUCTURE. Gambino, R. J.; Stemple, N. R.; Toxen, A. M. (IBM Watson Research Center, Yorktown Heights, N. Y.). J. Phys. Chem. Solids, 29: 295-302(Feb. 1968).

Studies were made of the crystal structure, metallurgical properties, and superconducting critical temperature of intermetallic compounds of lanthanum of the composition LaX_3, where X is tin, lead, thallium, and indium. These compounds are all congruently melting, and single crystals of the indium and tin compounds were prepared. X-ray measurements on carefully electropolished surfaces indicate that these compounds have the ordered Cu_3Au crystal structure. The tin, lead, and thallium compounds were found to be superconducting, with critical temperatures of 6.45, 4.05, and 1.57°K, respectively. The indium compound was not superconducting above 1°K. The critical temperatures do not appear to be related to interatomic spacing in the compounds, but rather seem to depend upon the valence of the element at the X sites. The compounds of lead and tin (quadrivalent elements) have the higher T_c's. The compounds of thallium and indium (trivalent elements) have the lower T_c's. (auth)

24224 THEORY OF STABILIZED SUPERCONDUCTING WIRES. Gauster, W. F.; Ullmaier, H. A.; Efferson, K. R.; Hendricks, J. B.; Wilkes, W. R. (Oak Ridge National Lab., Tenn.). Cryogenics, 8: 13-17(Feb. 1968).

Calculation methods for predicting the performance of stabilized superconducting wires ("compound conductors") are presented. The "ideal compound conductor" (superconductor in the nonresistive state) and the compound conductor with the superconductor in flux-flow state are considered. Experiments with ideal compound conductors were in good agreement with the theory. Otherwise only qualitative agreement could be achieved, and it is indicated what additional information should be provided in order to reconcile completely theory and experiment. (auth)

24225 UPPER CRITICAL FIELDS OF SUPERCONDUCTING MOLYBDENUM CARBIDES AT 4.2°K. Morton, N. (General Electric Co. Ltd., Wembley, Eng.). Cryogenics, 8: 30-1(Feb. 1968).

The superconducting properties of molybdenum wires carburized in xylene vapor were determined by measurements of the resistive transitions to the normal phase in applied magnetic fields. Two hexagonal carbides corresponding to the nominal compositions Mo_2C and MoC were obtained at different reaction temperatures, and their upper critical fields at 4.2°K were found to be 30 and 52 kOe, respectively. (auth)

24226 STUDY OF THE JOSEPHSON PLASMA RESONANCE. Dahm, A. J.; Denenstein, A.; Finnegan, T. F.; Langenberg, D. N.; Scalapino, D. J. (Univ. of Pennsylvania, Philadelphia). Phys. Rev. Lett., 20: 859-63(Apr. 15, 1968).

Direct observation is reported of the plasma resonance in Josephson tunnel junctions. The properties of the plasma mode are found to agree quantitatively with theoretical predictions. (auth)

24227 CURIE–WEISS BEHAVIOR AND FLUCTUATION PHENOMENA IN THE RESISTIVE TRANSITIONS OF DIRTY SUPERCONDUCTORS. Strongin, Myron; Kammerer, O. F.; Crow, J.; Thompson, R. S.; Fine, H. L. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev. Lett., 20: 922-5(Apr. 22, 1968). (BNL-12287).

By making very small mean-free-path films the intrinsic nature of resistive transitions was measured as a function of mean free path. Analysis based on the concepts of Anderson and Josephson leads to an estimate of the smearing of the transition near zero resistance. (auth)

24228 DEVELOPMENTS IN PRACTICAL SUPERCONDUCTIVITY. A SHORT REVIEW. Williams, I. (National Physical Lab., Teddington, Eng.). Proc. Brit. Ceramic Soc., No. 10, 169-82 (Mar. 1968).

The origin of superconductivity and the characteristic electrical and magnetic properties of type-I and type-II superconductors are outlined very briefly. The influence of compositional variables and microstructure is described, and the high-current high-field properties of commercial alloys are explained. A discussion of recent developments draws attention to the present status of refractory metal alloys and intermetallic compounds in magnet applications, the occurrence of structural transformations at very low temperatures in superconducting A15-type compounds, and the occurrence of superconductivity in ceramic semiconductors. (auth) (UK)

24229 METHOD OF FORMING SUPERCONDUCTIVE METAL LAYERS ON ELECTRICALLY NONCONDUCTIVE SUPPORTS. van de Stolpe, Cornelis; Marchand, Jean Francois (to North American Philips Co., Inc.). U. S. Patent 3,342,631. Sept. 19, 1967. Priority date Dec. 21, 1962, Netherlands.

A method is described for forming a superconducting layer of lead or tin on a support by first applying a copper layer and then replacing all or part of the copper with tin or lead from an alkali solution containing tin or lead ions. (M.H.R.)

24230 A CALORIMETRIC STUDY OF THE EFFECTS OF SURFACE ENERGY IN A TYPE-II SUPERCONDUCTOR. Rice, Robert Rex Cedric. Rolla, Mo., Univ. of Missouri, 1967. 127p.

Thesis.

A calorimetric study of the effects of the interphase surface free energy has been conducted on ellipsoidal samples of first and second kind superconductors. The measurements were performed using a specially designed magnetization calorimeter by two different techniques. The measurements were made on lead, tin, lead–4 at.% thallium, and tin–6 at.% indium. The results confirm the existence and expected sign of the surface energy in a well annealed lead–4 at.% thallium sample, and indicate that the interphase surface energy in lead and tin is too small to be directly detected by this method. The measured latent heats of transition of lead and tin agree well with the latent heats deduced from the critical field curves. The tin–6 at.% indium sample was too hysteretic to yield meaningful data. The results of measurements performed on lead–4 at.% thallium were compared to predictions based on laminar and vortex models of the mixed state. (Diss. Abstr.)

24231 CRITICAL MAGNETIC FIELDS OF THE SUPERCONDUCTING, SEMICONDUCTING, NONSTOICHIOMETRIC COMPOUNDS $Sn_{1-x}Te_1$ AT ULTRALOW TEMPERATURES. Hein, Robert Aloysius. Washington, D. C., Catholic Univ. of America, 1967. 173p.

Thesis.

The results of an experimental investigation of the occurrence and nature of superconductivity in the degenerate semiconducting SnTe compounds are presented. Magnetic susceptibility measurements were employed to measure the upper critical magnetic field, H_{c2}, as a function of temperature and composition of the sample. The composition range investigated corresponded to values of x, defined by the formula $Sn_{1-x}Te_1$, of $0.010 < x < 0.034$. Temperatures as low as 0.12°K were produced by means of the magnetic cooling technique. Magnetization curves were also obtained for various fixed values of the temperature. These studies clearly establish the nature of the superconducting state as type-II superconductivity. Analysis of the data in light of the GLAG theory of superconductivity indicates that the Ginsburg–Landau parameter, κ, for these samples is a function of the carrier concentration. κ varies from a high of 6.0 for the sample with $P^* = 20 \times 10^{20}$ cm^{-3} to a low of 3.9 for a sample with $P^* = 12.8 \times 10^{20}$ cm^{-3}. The temperature dependence of H_{c2} is found to obey the Gorkov prediction. The overall results of this investigation are in good qualitative agreement with the theoretical predictions of M. L. Cohen which relate to superconductivity among degenerate semiconductors and semimetals. Quantitative comparison must await a more detailed knowledge of the normal state parameters of these compounds. (Diss. Abstr.)

24232 ELECTRON TUNNELING IN SUPERCONDUCTING $Cd/Al_2O_3/Al$ JUNCTIONS. Kumbhare, Prabha Ramchandra. Ithaca, N. Y., Cornell Univ., 1967. 93p.

Thesis.

Films of cadmium metal were studied in the superconducting state using the technique of electron tunneling in $Cd/Al_2O_3/Al$ junctions. The variation of the energy gap of cadmium with temperature and magnetic field was determined from the current–voltage characteristics. The measured transition temperature of the cadmium films was 0.47°K, and the energy gap at 0°K, $2\Delta(O)$, was 0.13 ± 0.005 millivolts. The extrapolated value of the critical magnetic field at 0°K for these films ranged from 30 to 65 gauss. The derivative, (dV/dI), of the current–voltage characteristics was studied also as a function of temperature and magnetic field. Some extra structure was observed in (dV/dI) for voltages greater than $\Delta_{Al} + \Delta_{Cd}$. This extra structure is ascribed to tunneling through the edges of the cadmium films. (Diss. Abstr.)

24233 FLUXOID QUANTIZATION IN SUPERCONDUCTING VANADIUM. Spence, Stuart Thomas. Stanford, Calif., Stanford Univ., 1967. 104p.

Thesis.

Quantization of the fluxoid in small hollow cylinders of vanadium has been observed both below the superconducting transition temperature and in the transition region. This study was undertaken to try to reconcile the previous observations of quantization effects far below the transition temperature of vanadium with the fact that the predicted effect in the transition region was not observed in work by Meyers and Little. When a hollow cylinder is held at a fixed temperature in its transition region and an axial field is varied, fluxoid quantization will cause a downward shift in transition temperature periodic in the flux through it. This shift ΔT_c can be observed as a change in resistance, measured with a small direct current along the cylinder. When these measurements were made on vanadium by Meyers and Little they found no effect, although they could have observed one 200 X smaller than predicted. The experiment was repeated in the present investigation using a digital signal averager for increased sensitivity, with the results: (1) A temperature shift ΔT_c periodic in flux was found throughout the transition region. The period agreed with hc/2e, and the amplitude agreed well with that predicted by the Ginzburg–Landau theory. (2) Above a certain measuring current the amplitude of ΔT_c fell off very rapidly, and more rapidly at higher temperatures. This explains the previous nonobservance of the effect, and also the decrease of signal with temperature found in other metals. (3) The electron wavelength at this critical measuring current was comparable to the cylinder circumference; a structure appearing in the signal also suggested this was the cause of the decrease in ΔT_c. (TSS) (Diss. Abstr.)

24234 HYPERSONIC ATTENUATION IN SUPERCONDUCTING MERCURY. Ferguson, Richard Bert. St. Louis, Washington Univ., 1967. 83p.

Thesis.

The attenuation of longitudinal acoustic waves in polycrystalline mercury was measured in the normal and superconducting states between 1.5 and 4.2°K at a frequency of 9.2 GHz. The attenuation in the normal state is essentially constant in this range and has a value of about 2000 db/cm. The attenuation in the superconducting region has temperature dependence which can be fit with a single BCS curve characterized by $2\Delta(0)/k_BT_c = 3.9 \pm 0.2$. A pulse echo technique with piexoelectric generation and detection by means of a quartz rod in a microwave cavity was used. A novel technique for fabricating suitable sample which should be applicable for other metals with low melting points is described. A recently developed electronic sampling system for signal averaging was also employed. Work in mercury at lower frequencies has shown anomalous absorption similar to that in lead which has been explained to be due to interactions of the ultrasound with dislocations. These interactions are not expected to contribute significantly at 9 GHz, and the present results corroborate this explanation. The value of $2\Delta(0)/k_BT_c = 3.9$ is compared with 4.6 obtained from tunneling and infrared measurements and 3.95 from specific heat and critical field measurements. Possible explanations for this discrepancy are discussed. (Diss. Abstr.)

24235 LOW-TEMPERATURE ELECTRICAL RESISTIVITY OF PURE NIOBIUM. Webb, George Wendell. San Diego, Calif., Univ. of California, 1967. 85p.

Thesis.

The electrical resistance of pure niobium was measured as a function of temperature in the normal state, and as a function of temperature and longitudinal magnetic field in the superconducting state. The high purity of the niobium achieved in this experiment has made possible unambiguous measurements of the intrinsic resistivity at low temperatures. The normal-state measurements were carried out in the range from the superconducting transition (T_c = 9.25°K), to 300°K in zero magnetic field and from 2°K to 22°K in a magnetic field sufficient to quench all superconductivity. It is shown that the normal-state resistivity closely follows a T^5 law below 60°K. This behavior is discussed in terms of interband versus intraband scattering for the conduction electrons in niobium. The results are compared with the temperature dependence of resistivity found for other metallic elements in the periodic system. The suppression of superconductivity in niobium by a magnetic field was also studied. In particular, it was found that the ratio of the surface sheath critical field, H_{c3}, to the bulk critical field, H_{c2}, is temperature-dependent. This behavior has not been observed in alloy type-II superconductors. At T_c the ratio of the fields, called C, was found to be $1.67^{+0.00}_{-0.01}$. As the temperature was lowered C was found to increase linearly near T_c and then less rapidly as the temperature was lowered further. Extrapolating to absolute zero yields C = $1.89^{+0.00}_{-0.01}$. A comparison is made of the slope of C versus T (near T_c) with the recent theoretical work of Ebneth and Tewordt. (Diss. Abstr.)

24236 MICROWAVE MEASUREMENTS OF THE SURFACE IMPEDANCE OF SUPERCONDUCTING TIN AND LEAD. Turneaure, John Paul. Stanford, Calif., Stanford Univ., 1967. 81p.

Thesis.

The results of two different experiments are reported. In the first experiment, temperature-dependent measurements were made of the surface impedance of superconducting tin and lead at 2.85 and 11.2 GHz; these surface impedance measurements were compared with the Mattis and Bardeen theoretical result, including a finite electron-pair coherence length and a finite electron mean free path. In the second experiment, temperature dependent measurements were made of the ac critical magnetic field of superconducting tin at 2.85 GHz; these ac critical magnetic field measurements were compared with dc critical magnetic field measurements. To compare the Mattis and Bardeen theoretical result (MB) with the surface impedance measurements, MB was fit to the experimental data with the superconducting energy gap as a free parameter. The temperature dependence of the energy gap was taken to be that calculated from the BCS theory. For numerical evaluation, MB was reduced analytically to a double integral, including a finite electron-pair coherence length and a finite electron mean free path, and then numerically integrated. From the results of comparison, the following can be concluded: (1) the fit of MB to the data is adequate; (2) the values of the energy gap obtained for tin are in agreement with other published values; and those obtained for lead are most likely slightly lower than other published values, but small modification as the result of strong-coupling may account for these differences; and (3) the Mattis and Bardeen result is a considerable improvement over the semi-empirical Pippard function. Average values of the reduced energy gap (measured in units of k_BT_c) are (4.08 ± 0.03) for lead and (3.58 ± 0.01) for tin. Systematic errors may increase these error estimates. In the ac critical magnetic field measurements of tin, the transition to the normal state was observed as a sudden increase in the surface resistance to the normal-state value. For comparison of ac with dc measurements, the dc critical magnetic field was measured for tin electroplated on copper. The ac critical magnetic field was found to be consistent with the dc critical magnetic field. Also, the superconducting surface resistance was approximately a constant for magnetic fields less than the critical magnetic field. (TSS) (Diss. Abstr.)

24237 PROXIMITY EFFECT AND ELECTROMAGNETIC RESPONSE OF A CLEAN NORMAL–SUPERCONDUCTING SYSTEM. Leyendecker, Albert Jordon. College Park, Md., Univ. of Maryland, 1967. 93p.

Thesis.

A discussion of the effect of the pairing energy of superconducting electron pairs on the electromagnetic response of a superconductor is given. The importance of this energy on the electromagnetic response of any system containing superconducting pairs is emphasized. A model for calculating the electromagnetic response is chosen consisting of a finite section of normal metal plated on a semi-infinite superconductor. The Gor'kov formalism, allowing the complete description of a superconductor, is introduced. A linear approximation is made allowing the solution of the nonlinear Gor'kov equations. The probability of finding superconducting pairs in the normal metal for various temperatures and as a function of the normal metal thickness is given. The electromagnetic response problem is discussed and an explicit form is given for the conductivity function as a function of frequency for such a system is given. From an investigation of this function the energy important to the electromagnetic response is found to be the pairing energy of superconducting electrons as calculated in the bulk superconductor. The magnetic field response of the superconducting pairs in the normal metal, however, is found to be diminished from bulk response. A method of calculating the second-order corrections to the solutions of the Gor'kov equations is developed. It is shown that these corrections to the conductivity are small in the valid region of the theory. A comparison of these results to those of another quantum system is given. (Diss. Abstr.)

24238 STUDY OF SUPERCONDUCTIVITY IN ONE DIMENSION USING THE METHOD OF QUANTIZED SOUND WAVES. Schick, Michael. Stanford, Calif., Stanford Univ., 1967. 144p.

Thesis.

The question whether a system of electrons confined to a ring of negligible thickness exhibits the property of flux quantization characteristic of superconductors is examined, using the method of quantized sound waves. It is shown that operators which obey boson commutation relations under certain conditions can be introduced and that the Hamiltonian of the system of fermions, which interact by means of a two-particle interaction, can be expressed in terms of these operators. The resulting Hamiltonian contains terms which are bilinear or trilinear in the boson operators. Keeping only the bilinear terms, the Hamiltonian is diagonalized and the partition function determined. Expressions for the energy and current, valid for the ground state and for finite temperatures are obtained. The total free energy of the system is examined for the existence of relative minima at finite values of the current which would indicate that the system sustains persistent currents and exhibits flux quantization. No such minima are found at finite temperatures in the thermodynamic limit. The conditions under which the method of quantized sound waves is applicable are examined and restrictions on the temperature as well as the range and strength of interaction are obtained. These restrictions do not preclude the treatment of weak attractive interactions assumed to be responsible for superconductivity in three dimensions. (Diss. Abstr.)

24239 ULTRASONIC ATTENUATION IN NORMAL AND SUPERCONDUCTING LEAD. Fate II, William Arden. Troy, N. Y., Rensselaer Polytechnic Inst., 1967. 279p.

Thesis.

The longitudinal ultrasonic attenuation in normal and superconducting lead was investigated using the pulse-echo method at frequencies between 10 and 130 MHz in the temperature range 1 to 8°K. The investigation of the amplitude-independent attenuation was limited to sound propagation parallel to the [001] direction in single-crystal pure deformed lead and well-annealed alloys where the amplitude independence of the results was experimentally demonstrated. Methods for extracting electron mean free path values, l, from experimental attenuation data are discussed. The electron mean free path was evaluated for the specimens used in the experiments. The normal-state phonon-limited electron mean free path was found to be approximately proportional to T^{-4}. In the normal state the ql- and frequency dependence of the attenuation were in good agreement with the Pippard free electron attenuation theory. The temperature dependence of the superconducting-to-normal attenuation ratio was not in agreement with the BCS theory for any value of the zero-temperature energy gap. The attenuation ratio always decreased with decreasing temperature near the superconducting transition more rapidly than is consistent with the BCS theory. In pure deformed lead and for $T/T_c > 0.6$ (where the electron mean free path was phonon-limited), the attenuation ratio was frequency-dependent and dropped fastest below the transition at the lowest frequencies. In lead–tin alloys (where impurity scattering dominated the electron mean free path near the transition), the attenuation ratio was frequency-independent in the frequency range used. The experimental results are consistent with a smaller phonon-limited electron mean free path in the superconducting state than in the normal state. The data are semi-quantitatively interpreted on this basis. The attenuation data are not consistent with an amplitude-independent dislocation contribution to the low-temperature acoustic attenuation that changes at the superconducting transition. An approximate calculation of the dislocation damping factor due to electron-dislocation scattering is presented for the dislocation vibrating string model. In the normal state the damping factor B, as given by the present calculation, is of order 10^{-7} dyne sec cm^{-2} which is somewhat smaller than previous estimates, but is consistent with the

present experiments and some others. The analogous calculation for the superconducting state shows that the superconducting-to-normal B-factor ratio is the same as the theoretical superconducting-to-normal electronic attenuation ratio. A qualitative experimental study of the amplitude-dependent acoustic absorption was made in well annealed and deformed high-purity lead for longitudinal sound propagating parallel to the [001] and [111] directions. The amplitude-dependent acoustic loss was found to be temperature dependent in the superconducting state in disagreement with the Granato–Lücke theory. Also, the amplitude dependence of the attenuation was not in agreement with the Granato–Lücke theory. (Diss. Abstr.)

24240 SCINTILLATION OF LIQUID HELIUM UNDER PRESSURE. Agee, Forrest Jack Jr. Charlottesville, Va., Univ. of Virginia, 1967. 82p.

Thesis.

The scintillation of liquid helium induced by 5.28-MeV α particles has been investigated at temperatures between 1.26 and 4.20°K at pressures ranging from the vapor pressure to 7.8 atm. The temperature dependence of the pulse height at constant pressure resembles that observed previously at the vapor pressure in the He(II) region, with the exception that the break in the curve at low temperature occurs at a lower temperature at high pressure. The sharp decrease at the lambda line is not seen except at the vapor pressure. At constant temperature, the scintillation pulse height decreased as the pressure was raised from the vapor pressure until a minimum was reached at a pressure of from one to two atmospheres, above which pressure the luminescence increased monotonically with increasing pressure. The decrease was typically 3%, and the subsequent increase constituted 6 to 12% at 7.8 atm. The minimum occurred at a pressure of one atmosphere at the lowest temperature (1.26°K) and shifted to higher pressure above the lambda point to about two atmospheres at 4.20°K. The results are discussed in the light of (a) the contribution of recombination luminescence to the intensity, (b) the "bubble" model of electrons in liquid helium, and (c) the temperature and pressure dependence of the ionic diffusion coefficients. A description of the apparatus appears which includes the cryostat, pressure chamber, thermometry, pressure control and measurement, helium scintillation detection techniques, and a liquid level indicator. (auth)

Plasma and Thermonuclear Physics

Refer also to abstract 23360.

24241 (MATT-Q-25) ANNUAL REPORT, JANUARY 1–DECEMBER 31, 1967. (Princeton Univ., N. J. Plasma Physics Lab.). Mar. 1968. Contract AT(30-1)-1238. 376p. Dep. CFSTI.

Separate abstracts were prepared for the 14 individual sections. (M.O.W.)

For abstracts of individual sections see: 23360, 24242–24248, 24277–24281, and 24357.

24242 (MATT-Q-25, pp 30-117) STELLARATOR EXPERIMENTS. (Princeton Univ., N. J. Plasma Physics Lab.).

Results are discussed for the following studies: (1) identification of oscillation modes in strongly turbulent, microwave-heated stellarator plasmas, (2) confinement of injected plasma in stellarators, (3) normal and anomalous conductivity in the C stellarator from Thomson scattering measurements, (4) confinement of xenon plasmas in the C stellarator, (5) production and confinement of gun-injected plasmas in the C stellarator, (6) heating and containment of plasma with long mean free path in the C stellarator, (7) fluctuation studies in collisional and collisionless Ohmic-heated discharges, (8) ion-cyclotron instabilities in mirror-confined energetic plasma in the C stellarator, (9) limitations on ion-cyclotron resonance heating in a toroidal geometry, (10) optimum generation of ion-cyclotron waves in C stellarator, (11) local particle flux measurements in C stellarator discharges, (12) computer description of the C-stellarator Ohmic heating discharges in hydrogen, and (13) measurement of the rates of inelastic electron–atom collisions. (M.O.W.)

24243 (MATT-Q-25, pp 118-65) ALKALI PLASMA EXPERIMENTS. (Princeton Univ., N. J. Plasma Physics Lab.).

Results are presented for each of the following research areas: (1) correlation measurements of turbulent drift waves, (2) effect of shear on convective losses, (3) stabilization of collisional drift waves by large ion mass, (4) measurements of enhanced plasma losses caused by collisional drift waves, (5) measurement of neutral flux from volume recombination, (6) diffusion in narrow cesium plasma columns, (7) higher electron temperatures and increased end losses in Q devices, (8) a fully ionized barium plasma source, and (9) measurement of the rates of inelastic electron–atom collisions. (M.O.W.)

24244 (MATT-Q-25, pp 347-56) MECHANICAL ENGINEERING. (Princeton Univ., N. J. Plasma Physics Lab.).

Brief summaries of research progress are given for the following: (1) model C confining coil test program, (2) conductor insulation taping machine, (3) prediction of temperature in pulsed, water-cooled, hollow conductors using a simple computer code, and (4) superconducting characteristics of lead and suitable alloys. (M.O.W.)

24245 (MATT-Q-25, pp 357-63) MACHINES AND SYSTEMS. (Princeton Univ., N. J. Plasma Physics Lab.).

Research progress is discussed briefly for each of the following: (1) Princeton cyclotron, (2) a high-speed data aquisition system, (3) the Princeton floating multipole project, and (4) thermal degradation of lithium nitrite. (M.O.W.)

Confinement and Heating of Plasma

24246 (MATT-Q-25, pp 1-29) MULTIPOLE EXPERIMENTS. (Princeton Univ., N. J. Plasma Physics Lab.).

Results are presented on the following studies: (1) gun-injected plasmas in LM-1, (2) direct measurement of particle loss structure in a linear quadrupole, (3) oscillations of rf-produced plasmas in LM-1, and (4) plasma containment in a quadrupole machine. (M.O.W.)

24247 (MATT-Q-25, pp 201-22) EQUILIBRIUM AND MAGNETIC CONFIGURATIONS. (Princeton Univ., N. J. Plasma Physics Lab.).

Theoretical research is described for each of the following: (1) seedless multipoles or stellarators with internal separatrices, (2) effect of Dawson rings in the Model C stellarator, (3) Tokamak equilibrium for a guiding-center plasma, and (4) a fluid description of toroidal low-beta confinement. (M.O.W.)

24248 (MATT-Q-25, pp 321-40) MAGNETIC FIELD DEVELOPMENT. (Princeton Univ., N. J. Plasma Physics Lab.).

Research progress is described for the following: (1) higher derivatives on axis of an arbitrary coaxial coil system, (2) elimination of the double axes of an $l = 3$ stellarator field, (3) servo stabilization of levitated superconducting rings, (4) a compact toroidal dewar, and (5) a 110,000-ampere turn, quasi-persistent current ring. (M.O.W.)

24249 (AD-666140) POWERFUL SOURCES OF HIGH-VOLTAGE FEED OF INJECTORS AND QUESTIONS OF VOLTAGE STABILIZATION. Vasil'ev, R. P.; Kachalov, O. N.; Teplov, A. V.; Rubtsov, I. N.; Stepanov, U. N.; Ukhov, V. P. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Atomnoi Energii). Translation of report IAE-1100. 29p. (FTD-MT-24-90-67). CFSTI.

In connection with the subject of powerful sources of high-voltage feed of injectors and questions of voltage stabilization, the article discusses basic requirements on rectifiers and system of voltage stabilization. A fundamental circuit of high-voltage feed of ionic sources is described. Details and diagrams are furnished concerning: (1) rectifier for 200 kV, 10 A (VSM-200) and (2) rectifier for 130 kV, 50 A (IV-130). The article concludes with a description of systems of voltage stabilization of high-voltage supply sources. (auth)

24250 (AD-666145) DRIFTING INSTABILITY OF PLASMA OF DISCHARGE WITH OSCILLATORY ELECTRONS. Dushin, L. A.; Kuznetsov, Yu. K.; Pavlichenko, O. S. (Akademiya Nauk Ukrainskoi SSR, Kharkov. Fiziko-Tekhnicheskii Institut). Translated from report No. 197. 15p. (FTD-MT-24-152-67). CFSTI.

A study is made of previously observed increases in charged particle flux across a magnetic field, created by the discharge of oscillating electrons which produce intense low-frequency plasma oscillations. A study of these oscillations, and their genesis and frequency of occurrence as a function of plasma parameters, suggests that they are caused by the drift-dissipation instability of nonhomogeneous plasma. (auth)

24251 (AD-666156) DESIGNING OF INSTALLATION TOKAMAK TM-3. Ivanov, D. P.; Razumova, K. A.; Us, A. M. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Atomnoi Energii). Translation of report IAE-1104. 20p. (FTD-MT-24-88-67). CFSTI.

Installation "Tokamak TM-3" is intended for investigation of the confinement of hot plasma by a magnetic field of closed con-

figuration. Plasma heating is accomplished by flow of current along the plasma column. The installation is described in detail, including the winding of its magnetic field and its toroidal discharge chamber. (auth)

24252 (NP-tr-1618) SOME CHARACTERISTICS OF THE PLASMA COLUMN IN TM-3 AT HIGH INITIAL HYDROGEN PRESSURES. Bobrovskii, G. A.; Razumova, K. A. Translated for Culham Lab., Abingdon, Eng., from IAE report. 11p. (CTO-439). Dep. CFSTI. JCL $1.60 fs, $0.80 mf.

In Tokamak TM-3, over a given range of operating conditions, the displacement of the equilibrium position of the plasma column relative to the center of the discharge vessel, departs from the theoretically predicted displacement, and possible causes are discussed. (auth) (UK)

24253 (NP-tr-1636) EFFECT OF TOROIDICITY ON STELLARATOR MAGNETIC SURFACES. Danikin, I. S.; Karpenko, I. K. Translated for Culham Lab., Abingdon, Eng., from Preprint 114. 25p. (CTO-463). Dep. CFSTI. JCL $2.60 fs, $1.28 mf.

The magnetic surfaces of a stellarator with $l = 2$ are investigated in detail, taking into account the first correction for the curvature "K" of the system. In contrast to earlier papers, the expansion is extended over a wider region surrounding the magnetic axis the position of which, dependent on the current distribution in the helical stellarator windings, is determined by an exact solution for the potential of the magnetic field obtained earlier by Kovrizhnikh. This makes it possible to describe more precisely the system of magnetic surfaces in the region surrounding the axis and to consider the qualitative variation of their topology in the peripheral region (in the neighborhood of the separatrix of the initial system with $K = 0$). (auth) (UK)

24254 (NP-tr-1640) PRESENT STATE OF RESEARCH ON PLASMA DIFFUSION IN MAGNETIC FIELDS. Golant, V. E. Translated for Culham Lab., Abingdon, Eng., from report 013. 37p. (CTO-467). Dep. CFSTI. UK. JCL $3.60 fs, $1.34 mf.

A survey is given of experimental investigations of the transverse diffusion of charged plasma particles in a magnetic field. The experimental techniques used in determining the coefficient of diffusion in plasmas are reviewed and their limitations are analyzed. Methods based on measurements of transverse charged particle flux, of plasma lifetime, on investigations of the emission of plasma from a stationary source parallel to, and its propagation across, the magnetic field, and the analysis of the charged particle balance in the plasma are discussed. It is shown that the correct use of these techniques presents difficulties, so that it has often been difficult to obtain reliable quantitative data on the transverse diffusion of charged particles in a magnetic field. Some typical experiments designed to determine the diffusion coefficient in the simplest conditions are described, such as in a homogeneous magnetic field, or in the absence of a longitudinal current, of charged particle beams, or strong electric fields. (auth) (UK)

24255 (NP-tr-1644) PLASMA DIFFUSION IN A TOROIDAL STELLARATOR. Galeev, A. A.; Sagdeev, R. Z.; Fyurs, G. P. Translated for Culham Lab., Abingdon, Eng., from Preprint. 22p. (CTO-489). Dep. CFSTI. JCL $2.60 fs, $1.10 mf.

The influence of weak toroidality of the system on the motion of particles trapped in regions of minimum B in a strong helical field is investigated. It is shown that the drift orbits of the trapped particles (known locally as "bananas") execute a slow motion in the toroidal magnetic field. The maximum deviation of the "bananas" from the magnetic surface during such a motion is determined by the geometry of the magnetic field and the value of the equilibrium electric field, but is independent of the Larmor radius of the particles. The plasma transport coefficients, associated with the distortion of the plasma due to the drift of the "bananas," are calculated. For a small inverse aspect ratio the transport coefficients are significantly smaller than Bohm's diffusion coefficient D_B. Thus, the coefficient of the ion thermal conductivity is $f_{\perp i} < \epsilon_h^{\frac{1}{2}} \epsilon_i^2 D_B$, where $\epsilon_h < 1$ characterises the depth of modulation of the main field by the helical field. (auth) (UK)

24256 (NP-tr-1646) EXPERIMENTS ON ADIABATIC HEATING OF ELECTRONS IN A MAGNETIC TRAP. Ponomarenko, V. G.; Trainin, L. Ya.; Yurchenko, V. I.; Yasnetskii, A. N. Translated for Culham Lab., Abingdon, Eng., from Preprint. 12p. (CTO-491) Dep. CFSTI. JCL $1.60 fs, $0.80 mf.

Theoretical estimates are given of the effect of adiabatic heating on the motion of charged particles in a magnetic trap. Experimental oscillograms are shown of adiabatic heating and of the dependence of the electron containment time in the trap on the magnetic field during adiabatic heating. A method of obtaining large containment times (above 500 seconds) using adiabatic heating is described. (auth) (UK)

24257 (NP-tr-1648) THE BUNCHING OF ELECTRONS IN A MAGNETIC TRAP. Volosov, V. I.; Palchikov, V. E.; Tselnik, F. A. Translated for Culham Lab., Abingdon, Eng., from Preprint. 9p. (CTO-490). Dep. CFSTI. UK. JCL $1.60 fs, $0.80 mf.

The accumulation and containment of fast (up to 100 keV) electrons in a "magnetic trap" are investigated. The type of instability mainly observed during the experiment is related to the oscillatory motion of the electrons between the magnetic "mirrors" which limits the density of the "hot plasma." Certain characteristics of these oscillations are described, and a qualitative theory is put forward to explain the experimental results. (auth) (UK)

24258 A HIGH-TEMPERATURE, LOW-MAGNETIC-FIELD THETA PINCH. DeSilva, A. W.; Kunze, H.-J. (Univ. of Maryland, College Park). J. Appl. Phys., 39: 2458-63(Apr. 1968).

A theta-pinch device of low stored energy, constructed to provide a convenient spectroscopic source, has produced an interesting and useful plasma. The discharge tube has an ID of 15 cm and the coil is 32 cm long. The main bank energy is 9 kJ at 40 kV, and the current rings with a 7.5-μsec period. Plasma conditions have been investigated for a filling gas pressure of 12 m torr H_2 or D_2 and an antiparallel bias field of 500 G using light scattering, time- and space-resolved emission spectroscopy, streak photography, and neutron emission. These reveal that following the initial compression, the plasma forms a stable cylinder about 4.5 cm in diameter which persists for about 1.5 μsec. The maximum electron temperature, determined by light scattering, is about 260 eV. Absolute continuum emission and light-scattering measurements show the average electron density to be between 3 and 4×10^{15} cm^{-3}. The temperature of carbon impurity ions is determined to be 1.3 keV from Doppler broadening, and neutron emission with a deuterium filling indicates an ion temperature of about 700 eV. (auth)

24259 PLASMA HEATING AND DIFFUSION IN STOCHASTIC FIELDS. Puri, Satish. Stanford, Calif., Stanford Univ., 1967. 66p.

Thesis.

A comparison is made between an experiment on plasma heating by stochastic electric fields with a theory developed during the course of this work. A collisionless, lossless, "test particle" plasma is found to extract energy from an electric field both in the absence and the presence of a magnetic field. In the absence of a magnetic field, random heating is easily visualized as "diffusion in velocity space" and the heating rate is computed using time domain properties of the electric field. The study of the motion of electrons in a static magnetic field and a transverse random electric field allows us to determine the particle heating and diffusion rates in terms of the power spectrum of the fluctuating electric fields of arbitrary strength. The heating proceeds linearly in time and the plasma retains a Maxwell-Boltzmann velocity distribution. The above analysis assumes that each particle independently experiences a stationary random electric field. Later, it is shown by computer studies that the plasma has a marked tendency to assume a Maxwellian distribution when the particles move along a sinusoidally varying magnetic field instead of a uniform magnetic field even if they all see the random electric field. Further, it is found that the plasma heating rate is unchanged when small random fluctuations are introduced in the magnetic field variations as seen by the particle. In the experiment, a tenuous, collision-free sodium plasma in thermal equilibrium between two mirrors is heated by an externally applied random electric field. The experimentally determined heating rate is in good agreement with the theoretical predictions. It was also found that the random rf field at the electron cyclotron frequency suppressed a low frequency instability that was present. (Diss. Abstr.)

Diagnostics of Plasma

Refer also to abstracts 23375–23377.

24260 METHOD OF PLASMA ANALYSIS. Chirkov, V. P. (Rybinsk Aviation Tech. Inst., USSR). Geomagn. Aeron. (USSR) (Engl. Transl.), 7: 585-6(1967).

Translated from Geomagn. Aeron., 7: 719-20(1967).

This note describes one of the variants of the radio-frequency method of diagnosing a homogeneous plasma. The method is particularly effective when the collision frequency approaches the gyrofrequency of electrons. (W.D.M.)

24261 EFFECT OF PLASMA CONCENTRATION ON ELECTRON TEMPERATURE MEASUREMENT BY THE RELATION OF INTENSITIES OF HELIUM SPECTRAL LINES. Kozak, O. V.; Mikhatskaya, N. A.; Pasechnik, L. L. (Kiev State Univ.). Ukr. Fiz. Zh., 13: 130-3(Jan. 1968). (In Russian).

An optical technique was used for electron temperature mea-

surement by the relation of intensities of helium spectral lines at plasma densities 10^{11} to 10^{13} cm^{-3}. To check the results of optical measurements the Langmuir probe technique was used. It is shown that in using the line pair $\lambda = 5047$ and 4713 Å the results of electron temperature measurement by optical and probe techniques agree between themselves up to the densities 4×10^{12} cm^{-3}. (auth)

24262 ASYMPTOTIC THEORY OF A SPHERICAL ELECTROSTATIC PROBE IN A STATIONARY WEAKLY IONIZED PLASMA. Bienkowski, George K.; Chang, Kuo-wei (Princeton Univ., N. J.). Phys. Fluids, 11: 784-99(Apr. 1968).

The electrical effects of a charged sphere immersed in weakly ionized gas of infinite extent are analyzed on the basis of kinetic theory. Approximate solutions are obtained by the application of a moment method in which velocity space is split on the basis of exact orbit calculation, self-consistent with the field. The theory is shown to reproduce both the collisionless and the continuum results in the appropriate limits. Detailed analysis is performed asymptotically for small Debye length but arbitrary mean free path. For quantitative calculations a completely absorbing probe surface at a highly negative potential is chosen. Criteria for the collisionless or collision-dominated sheath are obtained explicitly. The voltage–current characteristics are presented in a form useful for direct prediction of electron number density in terms of measured voltage and current, provided the mean free path is known. If the mean free path is only estimated, the results can be used directly to check self-consistency of that estimate. (auth)

24263 MEASUREMENT OF LOW PLASMA DENSITIES IN A MAGNETIC FIELD. Chen, Francis F.; Etievant, Claude; Mosher, David (Princeton Univ., N. J.). Contract AT(30-1)-1238. Phys. Fluids, 11: 811-21(Apr. 1968). (MATT-558).

Absolute measurements of plasma density in the range 8×10^8 to 3×10^{11} cm^{-3} were made in a potassium plasma by four methods: (1) Langmuir probes, (2) microwave cavity, (3) microwave interferometry, and (4) propagation of electrostatic waves. Agreement to ≈25% between the probe and microwave measurements was achieved by careful application of probe theory. By contrast, indiscriminate use of probe theory would lead to an error of 600% at low densities. The fourth method, though less accurate, was found to be a useful independent check. (auth)

24264 INFLUENCE OF SECONDARY ELECTRONS ON AN ELECTRON-BEAM PROBE. Harbour, P. J.; Bienkowski, G. K.; Smith, R. B. (Princeton Univ., N. J.). Phys. Fluids, 11: 800-3(Apr. 1968).

The flow of secondary electrons, produced by ionization when an electron beam traverses a gas, is retarded by electrostatic fields and their density is higher than has previously been assumed. An experiment indicates that low energy electrons could have important effects on an electron-beam density and temperature probe and that further research is needed. (auth)

24265 THEORY OF FLAT-PLATE ION-DENSITY PROBE. de Boer, P. C. T.; Johnson, R. A. (Cornell Univ., Ithaca, N. Y.). Phys. Fluids, 11: 909-11(Apr. 1968).

Theoretical results are presented for the ion sheath which forms on a flat plate parallel to the stream direction of a slightly ionized gas. The boundary layer is assumed to be thin compared with the sheath. The solution obtained has a simple algebraic form. (auth)

24266 SPECTROSCOPIC STUDIES OF NONEQUILIBRIUM PLASMAS IN A LOW-ENERGY THETA PINCH. Prasad, A. N.; El-Karim, K. Abd (Univ. of Liverpool). J. Phys., B, 1: 77-8(Jan. 1968).

Detailed time-resolved measurements of the electron densities and temperatures in a high-density helium plasma generated in a theta-pinch discharge are reported (electron density $\simeq 5 \times 10^{17}$ cm^{-3}, temperature ≃55,000°K). In the later stages of the discharge the electron temperatures were estimated from both the parent helium radiation and from the radiation emitted by the successive ionization stages of the principal impurity, namely silicon, using a simplified collisional-radiative model. The two estimates of the temperature are in close agreement. The relative collisional-radiative ionization and recombination rates of the Si IV ion were deduced from the experimental data and are compared with theoretical estimates. The relative absorption oscillator strengths of some of the principal Si III and Si IV transitions in the visible spectrum based on the Coulomb approximation are shown to be consistent with the experimental values, except for the Si III 3d ^3D to 4p ^3P transition. (auth) (UK)

24267 STUDY OF DENSE PLASMAS BY DOUBLE FLOATING PROBE METHOD. Rohatgi, V. K. (Space Sciences Inc., Waltham, Mass.). J. Phys., D, 1: 485-9(Apr. 1968).

Measurements of the electron temperature in a confined electric arc at 1 atm were made using the double floating probe technique, and were found to be in good agreement with spectroscopic results. From these temperature plasma densities are calculated using the Saha equation for an equilibrium argon plasma. Near the probe, where local thermodynamic equilibrium conditions are not satisfied, the undisturbed electron densities are estimated using the continuum electrostatic probe theory. The results of these calculations are found to be consistent and in order of magnitude agreement, with the equilibrium plasma densities. (auth) (UK)

24268 EFFECTS OF CASCADING AND METASTABLE ATOMS ON THE DETERMINATION OF ELECTRON TEMPERATURE FROM RELATIVE LINE INTENSITIES IN A TENUOUS HELIUM PLASMA. Sovie, R. J. (Lewis Research Center, Cleveland). J. Quant. Spectrosc. Radiative Transfer, 8: 833-8(Feb. 1968).

The effects of cascading and electron–metastable atom interactions on the determination of electron temperature from the relative intensities of helium singlet and triplet series spectral lines are considered. It is found that the presence of metastable atoms will have a small effect if cascading effects are measured experimentally. Limitations on the applicability of the technique and criteria for determining its validity are presented. (auth) (UK)

24269 SPECTRA AND TOTAL RADIATION OF HYDROGEN PLASMA. Yakobi, Yu. A.; Komin, A. V.; Ivaniya, S. P. (Lebedev Inst. of Physics, Moscow). J. Quant. Spectrosc. Radiative Transfer, 8: 805-21(Feb. 1968). (In Russian).

Spectral and total radiation were calculated for a dense hydrogen plasma using an electronic digital computer for temperatures above 0.6 eV. The existence of domains of local thermodynamic equilibrium was assumed for the purpose of the calculations. (auth) (UK)

24270 DETERMINATION OF TEMPERATURE DISTRIBUTIONS IN HIGH-TEMPERATURE GASES BY THE TWO-SEEDING METHOD. Tien, C. L.; Pelech, I. (Bell Telephone Labs., Inc., Whippany, N. J.). J. Quant. Spectrosc. Radiative Transfer, 8: 685-91(Feb. 1968).

A method is proposed for determining the temperature distribution in high-temperature gases by measuring radiation from seeded emitters at two different seeding rates. The problem of a cylindrical gas body with temperature varying only in the radial direction is analyzed in detail. In contrast to previous work, based on one seeding rate, the present method does not require any accurate knowledge of the spectral characteristics and concentrations of seeded emitters. (auth) (UK)

24271 THOMSON AND RAYLEIGH DIFFUSION IN AN ARGON PLASMA JET. Decroisette, M.; Cabannes, F. (CNRS, Paris). J. Quant. Spectrosc. Radiative Transfer, 8: 619-30(Feb. 1968). (In French).

Experimental determination of electron density in the jet nozzle of an argon plasma torch by Thomson scattering of a ruby laser beam is reported. The results are compared with those obtained from other processes (absolute continuum, absolute intensity of the Ar I 4044 Å line). The experimental setup makes it possible to determine the absolute value of the differential scattering cross section; it is found to be in agreement with the theoretical value of $\sigma' = 0.47 \times 10^{-26}$ cm^2. (auth) (UK)

24272 MICROWAVE DIAGNOSIS OF INHOMOGENEOUS PLASMA BOUNDARY LAYERS. Flynn, James Terrence. Columbus, Ohio, Ohio State Univ., 1967. 79p.

Thesis.

Diagnosis of an inhomogeneous plasma using a microwave device for measuring reflection and transmission coefficients is described. A method has been developed for theoretically evaluating the reflection and transmission coefficients for oblique incidence of plane, TE waves on inhomogeneous plasma profiles when asymptotic solutions of the wave equation are not available. A general model using Gaussian distributions is proposed and the model is matched to a shock tube plasma. Diagnosis of the plasma is accomplished by matching theoretical reflection and transmission coefficients to the measured data. (Disser. Abstr.)

24273 MICROWAVE DIAGNOSTICS OF RADIO-FREQUENCY PLASMAS. Storm, Richard Perry. Austin, Tex., Univ. of Texas, 1967. 233p.

Thesis.

Microwave diagnostics of radio-frequency plasmas were carried out with a 70 GHz microwave interferometer and a 2.6 to 12.4-GHz radiometer of low sensitivity. The electron densities of hydrogen, helium, argon, and cesium rf-generated plasmas as well as cesium contact plasmas were measured for pressures from 1 to 330 milli torr over a range of magnetic field strength from zero to 1800 G in which "anomalous" diffusion effects and the

lower ion–electron hybrid resonance of electromagnetic wave propagation occurred. (Disser. Abstr.) (TSS)

24274 THEORY OF THE PLASMA RESONANCE PLANE PROBE. Li, Nelson Chin-shui. Lafayette, Ind., Purdue Univ., 1967. 97p.

Thesis.

It is shown theoretically how a conducting plane probe behaves when it is immersed in a plasma, and has both a dc and an rf potential applied to it. The rectified current which flows to the probe is derived as a function of the frequency of the applied voltage. Resonance phenomena are shown to occur at a frequency somewhat less than the plasma frequency. The collisionless Boltzmann–Vlasov equation, together with Poisson's and Maxwell's equations are used to derive respectively, the dc potential distribution based on Bohm's sheath model, and the integral equation governing the alternating electric field in the plasma. The alternating electric field is calculated numerically and the calculations show the penetration of the rf electric field into the plasma. The rectified electron current and its resonance rectification are obtained by a consideration of electron trajectory perturbations produced by the rf electric field. Collisions are neglected and all magnetic field effects are omitted. (Diss. Abstr.)

Kinetics of Plasma

Refer also to abstracts 24029, 24108, and 24357.

24275 (CEA-R-3413) METHODE DE CALCUL DE LA RELATION DE DISPERSION D'UN PLASMA COLLISIONNEL. (Calculation Method for the Dispersion Relation of a Collisional Plasma). Lafleur, Charles (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Dec. 1967. 8p. (In French). (EUR-3585). Dep.

Starting from kinetic equations derived from the Fokker–Planck term introduced by Chandrasekhar, the dispersion relation of a homogeneous plasma is obtained easily through the use of a convenient set of eigenvalue functions. (auth)

24276 (LA-3831(Add.)) STATUS REPORT OF THE LASL CONTROLLED THERMONUCLEAR RESEARCH PROGRAM FOR 12-MONTH PERIOD ENDING OCTOBER 31, 1967. (Los Alamos Scientific Lab., N. Mex.). 5p. Dep. CFSTI.

Brief theoretical discussions are presented on the following research areas: (1) Hamilton's principle and numerical solution of the Vlasov equations, and (2) the motion of a time-dependent harmonic oscillator and the motion of a charged particle in a class of time-dependent, axially symmetric electromagnetic fields. (M.O.W.)

24277 (MATT-Q-25, pp 166-82) SOLID-STATE PLASMA EXPERIMENTS. (Princeton Univ., N. J. Plasma Physics Lab.).

Research is reported on the following three topics: (1) cross-field diffusion of a solid-state plasma, (2) the interaction between an electron beam and a whistler in a solid-state plasma, and (3) direct observation of the diffusion of solid-state plasma in a magnetic field. (M.O.W.)

24278 (MATT-Q-25, pp 183-99) LILO AND OTHER EXPERIMENTAL WORK. (Princeton Univ., N. J. Plasma Physics Lab.).

The Lilo program (large ion Larmor orbit) is briefly described. The propagation and absorption of hydromagnetic waves near the ion cyclotron frequency were studied in a hot plasma. Abstracts of other research work are given. (M.O.W.)

24279 (MATT-Q-25, pp 239-56) NONLINEAR EFFECTS AND TURBULENCE. (Princeton Univ., N. J. Plasma Physics Lab.).

Theoretical research is described for the following: (1) some constants of the linearized motion for perturbations of large-amplitude electrostatic waves, (2) plasma convection from large-amplitude waves, and (3) nonlinear effects of ion drift waves. (M.O.W.)

24280 (MATT-Q-25, pp 257-303) GENERAL PLASMA PHYSICS. (Princeton Univ., N. J. Plasma Physics Lab.).

Theoretical results are briefly described for the following: (1) kinetic theory of stable and weakly unstable plasmas, (2) cosmic rays and ion cyclotron resonance, (3) absorption of laser radiation by over-dense plasma, (4) cyclotron resonance heating of plasma, (5) viscous diffusion in cesium plasmas, and (6) observations of collisional absorption and emission of longitudinal waves in a one-species, one-dimensional plasma. (M.O.W.)

24281 (MATT-Q-25, pp 305-20) ELECTRONICS AND INSTRUMENTATION. (Princeton Univ., N. J. Plasma Physics Lab.).

Research on the following topics is discussed: (1) a microwave radiation detector and alarm, (2) the LM-1 plasma heating systems, (3) utilization of industrial heating magnetrons for plasma heating, (4) new microwave apparatus for plasma density measurements, and (5) digital computer simulation of a duoplasmatron ion source. (M.O.W.)

24282 (ORO-3647-2) OBLIQUE COLLISIONLESS SHOCKS AND PLASMA TURBULENCE. Progress Report No. 2. (Texas Univ., Austin. Center for Plasma Physics and Thermonuclear Research). Apr. 1968. Contract AT(40-1)-3647. 15p. Dep. CFSTI.

Experimental work has continued on the apparatus described earlier (ORO-3647-1) to study the structure of oblique shock waves in plasma. Concurrently, the computer code which predicts the shock structure on the basis of collisional transport coefficients has been developed to compare experiment and theory at each stage. The most significant results have been obtained by comparing shocks in hydrogen at 20 mtorr and in deuterium at 10 mtorr. These conditions produce plasmas of identical mass density and, therefore, identical dynamic behavior, but with different transport coefficients, since the ion–ion collisional mean free path in deuterium is eight times that in hydrogen. The results to date indicate that in the case of deuterium, collisional effects alone are not sufficient to account for the structure and that some collisionless interaction between the ions, giving rise to a reduced viscosity coefficient, is occurring. The cause of this anomalous viscosity is probably a streaming type of instability, but its precise nature remains to be identified. (auth)

24283 (SIT-2813-44) ANNUAL PROGRESS REPORT [ON CROSS-FIELD DIFFUSION IN CONFINED PLASMA COLUMN]. Rogers, Kenneth C.; Motz, R. O. (Stevens Inst. of Tech., Hoboken, N. J. Dept. of Physics). Feb. 1968. Contract AT(30-1)-2813. 17p. Dep. CFSTI.

The study of transverse diffusion in a single-ended potassium Q-device was completed. A new Q-device designed specifically for the generation of and optical studies on a barium Q-plasma is described. Theoretical studies on atomic and optical properties of the Ba^+ ion are discussed. Experimental optical studies of a small prototype barium Q-plasma are also described briefly. (M.O.W.)

24284 (AD-666147) ANOMALOUS ABSORPTION OF ELECTROMAGNETIC ENERGY IN PLASMA. Suramlishvili, G. I.; Ponomarenko, Yu. B. Translated from Soobshch. Akad. Nauk Gruz. SSR, 40: 47-53(1965). 13p. (FTD-MT-24-150-67). CFSTI.

The effect of anomalous absorption of the energy of an electromagnetic wave which is perpendicularly incident to the surface $z = 0$ of a semi-infinite plasma was studied. An expression is given for the amplitude of the wave inside the plasma in terms of the amplitude of the incident wave. The dispersion equation for potential perturbations of the stationary state is analyzed for the case where electrons are in motion with a given vector with respect to ions. The consideration is limited to the case of cold ions and motion of the ions in the wave field is disregarded. The hydrodynamic oscillations described by this analytical function are discussed. Expressions are derived for critical conditions and instability. The limits of applicability for the proposed model of energy absorption are analyzed. (auth)

24285 (AD-666148) WORK OF HIGH-POWER HIGH-FREQUENCY GENERATOR INTO PLASMA LOAD. Borzunov, N. A.; Osovets, S. M.; Petrov, Yu. F.; Popov, I. A. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Atomnoi Energii). Translation of report IAE-1105. 15p. (FTD-MT-24-89-67). CFSTI.

Experiments conducted on installations with traveling waves showed that the appearance of quasi-stationary current in skin layer of plasma in direction of travel of wave can be a serious obstacle to the production of plasma isolated from the walls of the chamber. Experience further indicates that it becomes necessary to strongly increase the power of hf generators to obtain high-frequency magnetic fields which will sufficiently exceed the quasi-stationary magnetic fields. An experimental installation to compensate for the effects of the quasi-stationary current is described. (auth)

24286 PLANE WAVE SCATTERING BY A PIECE-UNIFORM PLASMA WITH A ZERO LAYER. Buts, V. A. (Ukrainian Correspondence Polytechnic Inst., Kharkov). Izv. Vyssh. Ucheb. Zaved., Radiofiz., 11: 44-9(1968). (In Russian).

The scattering of a plane wave by piece-uniform plasma located in the lower half-space in the presence of the zero (resonance) layer is discussed. The problem is reduced to the boundary conjugate problem for analytical functions and to the Fredholm's equation of the second order. Simple cases of the solution of these equations are considered. (auth)

24287 ELECTRON DISTRIBUTION FUNCTION OF AN ISOTROPIC AND HOMOGENEOUS LORENTZIAN PLASMA IN THE PRESENCE OF A FREQUENCY-MODULATED ELECTRIC FIELD. Allouche, Daniel; Jancel, Raymond; Kahan, Theo (Institut Henri Poincare, Paris). Compt. Rend., Ser. A and B, 266: 321-3 (Feb. 5, 1968). (In French).

The electron distribution function of an isotropic and homogeneous Lorentz plasma exposed to the effect of a frequency-modulated electric field was calculated. The result is applied to the calculation of the electron current. (tr-auth)

24288 PLASMA POTENTIAL VARIATIONS IN MOVING STRIATIONS. Drouet, Michel G. (Univ., Montreal). Can. J. Phys., 46: 227-9(Feb. 1, 1968).

A method is proposed to obtain measurements of time variations of plasma potential in moving striations. The measurements are obtained using a modified version of the two probe techniques proposed by Crawford et al. (1963) and which was then used to obtain electron velocity distribution. The modification consists essentially in the addition of a sampling technique to resolve the time variations of the first derivative obtained by the two probes and due to the striations. A typical oscillographic record is presented to illustrate the method. (M.O.W.)

24289 NONLINEAR WAVES IN A PLASMA WITH AN ARBITRARY ELECTRON VELOCITY DISTRIBUTION IN THE PRESENCE OF A MAGNETIC FIELD. Akhiezer, I. A.; Borovik, A. E. (Kharkov Inst. of Physics and Tech.). Ukr. Fiz. Zh., 13: 11-18(Jan. 1968). (In Russian).

Nonlinear motions are investigated in a plasma consisting of hot electrons and cold ions in the presence of a constant uniform magnetic field. Stationary waves (solitary waves and quasi shocks with oscillation structure) are considered. It is shown that in plasma in the presence of the magnetic field nonlinear waves also essentially depend on the character of the electron velocity distribution as it was previously established for plasma in the absence of the field. Depending on the character of the electron velocity distribution two cases are possible: either the normal case, when discontinuities (or additional ion beams) arise in the compression regions and solitary and quasi-shock waves are compression waves, or the anomalous one, when discontinuities arise in the rarefaction regions and solitary and quasi-shock waves are rarefaction waves. (auth)

24290 PARTICLE DISTRIBUTION IN THE NEIGHBORHOOD OF AN INFINITE CHARGED CYLINDER IN A PLASMA. Dyukalov, A. N.; Borisov, N. F. Geomagn. Aeron. (USSR) (Engl. Transl.), 7: 586-8(1967).

Translated from Geomagn. Aeron., 7: 721(1967).

The distribution of charged particles in the neighborhood of an infinite charged cylinder in a plasma is analyzed by the method proposed by Goryshnik and Dyukalov (Geomagn. Aeronomiya, 5: No. 3, 401(1965)). It is easy to demonstrate that study of repelled particles does not present any difficulty and, therefore, attention is paid mainly to attracted particles. (W.D.M.)

24291 HODOGRAPHIC METHOD IN THE ELECTRODYNAMICS OF CONTINUOUS, NONLINEAR, CONDUCTING MEDIA. Emets, Yu. P. Prikl. Mat. Mekh., 31: 1077-80(Nov.-Dec. 1967). (In Russian).

There is a wide class of conductors, where the linear relation between current density and electric field tension is disturbed in the presence of strong electric fields. The deviation from Ohm's law is observed in media such as in a plasma and in a semiconductor. The physical reason for the nonlinear conductivity is due to the nonequilibrium state of the current carriers. Due to the nonlinearity of the initial equations the electrodynamic equations are linearized by a hodographic conversion, and an effective method of calculating the electric fields in nonlinear conducting media is obtained by the use of approximation methods. The physical nature of the nonequilibrium conductivity of a plasma is considered for cases where the conductivity depends weakly on the current density. If a certain critical electron velocity is exceeded, it is possible to obtain discontinuities of the electric field in the plasma. (TTT)

24292 "ISOMAGNETIC JUMP" IN THE FRONT OF A STRONG COLLISION-FREE SHOCK WAVE. Kurtmullaev, R. Kh.; Masalov, V. L.; Mekler, K. I.; Pil'skii, V. I. (Inst. of Nuclear Physics, Novosibirsk, USSR). JETP Lett. (USSR)(Engl. Transl.), 7: 49-52 (Jan. 30, 1968).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 7: 65-70(Jan. 30, 1967).

The results are presented of the distribution of the density and magnetic field when the strong shock wave goes through the critical Mach number $M_{cr} \simeq 3$. (M.O.W.)

24293 NONLINEAR EXCITATION OF PROPAGATING SURFACE WAVES ON A PLASMA COLUMN. Ajmera, R. C.; Lonngren, K. E. (Univ. of Iowa, Iowa City). J. Appl. Phys., 39: 2265-8(Apr. 1968).

Experimental results are presented of the nonlinear excitation of a propagating surface wave on a plastic column. The dispersion characteristics of this wave are compared with those obtained from a linear excitation. The possible mechanisms of the nonlinear excitation are also discussed. (auth)

24294 RADIAL STRUCTURE OF A LOW-PRESSURE GAS DISCHARGE WITH GENERATION OF WARM IONS. Bardotti, G.; Dentoni, A.; Engelmann, F. (EURATOM–CNEN, Rome). Nuovo Cim., 54B: 253-9(Apr. 11, 1968).

The effect of a velocity spread of the ions at the moment of their generation on the radial variation of the potential in the positive column of a low-pressure gas discharge in a steady state is discussed by solving numerically the corresponding integral equation. Explicitly, a model of plane geometry is treated. It is shown that for any value of the temperature T_n of the ions at generation, there is a uniquely defined critical wall potential φ_c below which a space-charge-dominated sheath occurs at the wall. In these cases, the shape of the potential in the inner, quasi-neutral region is independent of the wall potential. The variation of φ_c with T_n is weak, so that for many practical purposes the cold approximation ($T_n = 0$), usually adopted, seems quite satisfactory. (auth)

24295 NORMAL MODES OF A NONUNIFORM PLASMA. Leavens, W. M.; Larson, R. W.; Love, C. H. (Environmental Science Services Administration Research Labs., Boulder, Colo.). Phys. Fluids, 11: 917-18(Apr. 1968).

The spectrum of undriven electron plasma oscillations of a realistic, nonuniform, collisionless plasma with a sheath is determined. The spectrum is found to be discrete. (auth)

24296 INTEGRAL EQUATION TREATMENT OF THE LINEARIZED THEORY OF ELECTROSTATIC PLASMA OSCILLATIONS. Lee, D. A.; Soper, G. K. (Wright-Patterson AFB, Ohio). Phys. Fluids, 11: 918-20(Apr. 1968).

It is shown by an example that it is convenient and physically revealing to solve certain initial value problems for the Vlasov equation directly, in the form of an integral equation for the disturbance in electron-number density, without using integral transforms. (auth)

24297 MOBILITY TENSOR FOR A STRONGLY TURBULENT LORENTZ GAS IN A MAGNETIC FIELD. Frank, Eugene N. (Case Inst. of Tech., Cleveland). Phys. Fluids, 11: 911-13(Apr. 1968).

The magnetic field terms of the Fourier analyzed momentum equation of a turbulent Lorentz gas are linearized using a phenomenological approach. The perpendicular mobility is found to vary as B^{-q} where $0.6 < q < 2.0$. (auth)

24298 EFFECT OF NEUTRAL IMPURITY LEVELS ON THE OSCILLATION SPECTRUM OF A MAGNETOPLASMA. Eastlund, B. J. (Columbia Univ., New York); Leheny, R. F.; Granatstein, V. L.; Schmidt, P. H. Phys. Fluids, 11: 915-16(Apr. 1968).

Neutral gases were added to a chamber containing a fully ionized magnetoplasma. Above certain critical background pressures, naturally occurring drift waves were quenched and a new low-frequency wave appeared. The wave quenching is attributed to ion–atom collisions. (auth)

24299 HIGH-FREQUENCY BREAKDOWN OF NONUNIFORM GASES IN SPATIALLY VARYING FIELDS. Epstein, Melvin (Aerospace Corp., El Segundo, Calif.). Phys. Fluids, 11: 896-902(Apr. 1968).

A method is described for predicting the field strength required to produce continuous wave breakdown of gases with spatially varying properties subjected to electric fields of nonuniform intensity. The proposed method is based on a variational principle derived from the electron continuity equation. A Ritz method is used to generate solutions of the variational problem. The approximate solutions are evaluated by comparing them with several exact solutions which are also developed. The use of a one-term trial function in the Ritz method is found to give very good agreement with the exact solutions. A two-term approximation provides greater accuracy than is presently available from experimental data. (auth)

24300 LONGITUDINAL WAVES EXCITED IN AN INHOMOGENEOUS MAGNETIZED PLASMA SLAB. Gruber, S. (Case Western Reserve Univ., Cleveland). Phys. Fluids, 11: 858-68 (Apr. 1968).

Excitation of short wavelength longitudinal oscillations in a plasma slab is considered for frequencies near the second harmonic of the electron cyclotron frequency. For the uniform

plasma slab a long and short wavelength plasma oscillation coupled at the boundary and the relative amplitudes are governed by the boundary conditions. In the nonuniform plasma slab these two fields are continuously coupled within the slab as well as at the boundaries. When the boundaries are removed, these fields are coupled by the density gradient and the rapidly varying field is of amplitude λ^2/L^2 less than the long wavelength field where λ is the wavelength and L is the scale size. The slab plasma exhibits a series of resonances and antiresonances as a function of field B when $B > m\omega/2e$ and shows an antiresonance for an excitation frequency slightly greater than the second harmonic. An experiment verified this predicted antiresonance. (auth)

24301 KINETIC THEORY OF PLASMA-WAVE MOTION IN THE PRESENCE OF COLLISIONS. Porkolab, Miklos (Stanford Univ., Calif.). Phys. Fluids, 11: 834-43(Apr. 1968).

Utilizing a Krook-type collision integral, a systematic analysis was made of electrostatic waves and instabilities in a fully ionized, low β, inhomogeneous plasma (where β is the ratio of particle pressure to magnetic pressure). The model employed is that of a plasma slab supported by magnetic and gravitational fields. In particular, the dispersion relations for drift waves, appropriate to a short system, and for ion cyclotron waves are derived and discussed. Thus, for drift waves it is found that in the presence of collisions, ion motion parallel to the magnetic field can provide a strong stabilizing effect for sufficiently large values of the axial wave vector. For the two-stream ion cyclotron instability it was found that ion–ion collisions can provide strong damping even for collision frequencies well below the ion cyclotron frequency. (auth)

24302 EFFECTS OF COLLISIONS ON LANDAU DAMPING. Rand, S. (Univ. of California, San Diego, La Jolla). Phys. Fluids, 11: 844-51(Apr. 1968).

The quasilinear theory of Drummond and Pines has been extended in order to include the effects of collisions, and the resulting equations have been solved in the steady state. The extent to which collisions cause a reduction in Landau damping is demonstrated. Results are given in terms of the two parameters, $\omega/k\bar{v}$ and $e^2E_0^2/m^2\bar{v}^3k\beta$, where ω and k are the frequency and wavenumber of the propagating wave field, of peak electric field strength E_0, $\bar{v}$ is the electron thermal speed, and β is the 90° deflection frequency of Spitzer, corresponding to an electron which moves with the phase velocity of the wave. (auth)

24303 FIRST-ORDER ORBIT THEORY OF THE ROTATIONAL DISCONTINUITY. Su, Shin-yi; Sonnerup, B. U. O. (Dartmouth Coll., Hanover, N. H.). Phys. Fluids, 11: 851-7(Apr. 1968).

A study is made of the propagation properties and internal equilibrium structure of a large-amplitude Alfvén wave which conserves the magnitude of the magnetic-field component tangential to the wave front but changes its direction. The propagation properties are found to be identical with those of small-amplitude sinusoidal waves. The equilibrium wave structure is shown to involve an electric field along the wave normal. The sign and magnitude of this field are related to the rate and sense of rotation of the tangential magnetic field component as well as to the particle distributions. In certain cases the electric field may be sufficiently large to cause nonnegligible variations in particle and magnetic pressures within the wave. Observed polarizations of the magnetopause current layer may be explained by the theory. (auth)

24304 PHYSICAL INTERPRETATION OF THE UNIFIED THEORY OF RELAXATIONS IN PLASMAS. Aono, Osamu (State Univ. of New York, Buffalo). Phys. Fluids, 11: 832-3(Apr. 1968).

An elementary analysis of frictional force suffered by a test particle traveling fast through a plasma is considered. The action of the system on the particle is described as a result due to the nonlinear polarization of the plasma. The friction thus calculated is in good agreement with that obtained on the basis of the unified theory. (auth)

24305 NONADIABATIC BEHAVIOR OF PLASMA OSCILLATIONS. Bartlett, Charles J. (Smithsonian Astrophysical Observatory, Cambridge, Mass.). Phys. Fluids, 11: 822-31(Apr. 1968).

The nonadiabatic behavior of electrostatic oscillations in an initially unstable, collisionless, field-free plasma is discussed. The equations of ordinary quasilinear theory are generalized to include the time rates of change of the oscillation frequency and the spatially homogeneous part of the distribution function. Certain aspects of the more general theory are illustrated by a discussion of the problem of interpenetrating electron and ion beams. The behavior of the instability is found to differ markedly from that predicted by quasilinear theory. Many of the findings are verified by a direct comparison with the results obtained by Buneman from computer experiments. (auth)

24306 ION VELOCITY DISTRIBUTIONS IN A PARTIALLY IONIZED PLASMA. Banks, Peter M.; Lewak, George J. (Univ. of California, San Diego, La Jolla). Phys. Fluids, 11: 804-10 (Apr. 1968).

Calculations have been made of the steady-state ion velocity distribution functions for a partially ionized gas which is not in thermal equilibrium. The electron and neutral gases are assumed to have Maxwellian distributions such that $T_e \geq T_n$. The effects of ion–electron and ion–ion Coulomb collisions are represented by appropriate Fokker–Planck terms, while the ion–neutral collision term has been derived for resonance charge exchange. It is found for the case of atomic oxygen ions that little distortion of the ion distribution from Maxwellian occurs for ranges of electron and neutral temperatures and particle number densities of geophysical interest. Further, even if ion–ion collisions are neglected, a nearly Maxwellian distribution results for steady-state conditions. (auth)

24307 ELECTROSTATIC EQUILIBRIUM OF ELECTRON CLOUDS IN MAGNETIC FIELDS. Levy, R. H. (Avco Research Lab., Everett, Mass.). Phys. Fluids, 11: 772-83(Apr. 1968).

An electron cloud surrounding a toroidal satellite and held in place by a strong magnetic field ($B^2/2\mu_0 \gg \frac{1}{2}\epsilon_0 E^2 \approx n_e eV \gg n_e kT_e$) has been suggested as a means of raising the satellite to a large positive potential. Symmetry ensures that the $E \times B$ drift of the electrons satisfies the continuity equation, and the problem of steady equilibrium is reduced to finding electron density distributions such that $E \cdot B = 0$ wherever electrons are present; in other regions $n_e = 0$. It is shown that the development of a "hole" in the electron cloud at large distances from the axis of symmetry is likely. Representative two-dimensional models are analyzed. At the edge of the electron cloud the appropriate boundary condition is closely related to the Kutta–Joukowski condition of elementary aerodynamics. (auth)

24308 COMPUTER EXPERIMENTS ON LOW-DENSITY CROSSED-FIELD ELECTRON BEAMS. Levy, R. H.; Hockney, R. W. (Avco Research Lab., Everett, Mass. Stanford Univ., Palo Alto, Calif.). Phys. Fluids, 11: 766-71(Apr. 1968).

A Lagrangian computer model consisting of 1000 electron rods has been used to investigate the long-wave diocotron instability in a low-density ($\omega_p^2 \ll \omega_c^2$), re-entrant, crossed-field electron beam. A thick and thin beam were found to be stable and unstable, respectively, as predicted by theory. Excellent agreement was obtained between the theoretical growth rate and that observed in the model. The computer model was able to follow the nonlinear behavior of the system. The unstable beam broke up into a vortex street which remained for a long time. The size of the vortex was not enough to transport electrons to the wall of the system and the beam remained confined to the interior. (auth)

24309 PROPERTIES OF THE FOKKER–PLANCK EQUATION. Lewis, M. B.; Hogan, J. T. (Northwestern Univ., Evanston, Ill.). Phys. Fluids, 11: 761-5(Apr. 1968).

The expansion of the Boltzmann collision term up to second order in small deflections is shown to agree with the corresponding expansion of the Smoluchowski equation for arbitrary potentials. A general relation is obtained for the nth Fokker–Planck coefficient and (velocity) derivatives of higher coefficients. (auth)

24310 OPTIMUM SEEDING OF A NONEQUILIBRIUM HELIUM PLASMA WITH CAESIUM. Guha, S.; Kaw, P. K. (Indian Inst. of Tech., New Delhi). J. Phys., D, 1: 375-6(Mar. 1968).

An earlier treatment of optimum seeding of helium with cesium was modified by taking account of the dependence of the electron temperature on the seeding ratio. Some qualitatively new conclusions are drawn. (auth) (UK)

24311 PLASMA PHENOMENA AND THE SOLID STATE. Hoyaux, M. F. (Carnegie Inst. of Tech., Pittsburgh). Contemp. Phys., 9: 165-96(Mar. 1968).

It is stated that plasma phenomena in the solid state combine the essential characteristics of the gaseous plasma with those of the solid state, such as band structure, degeneracy and anisotropy, and lead to new and interesting types of behavior. (auth) (UK)

24312 DENSITY-FLUCTUATION APPROACH TO THE CLASSICAL PLASMA. Gaskell, T. (Univ. of Sheffield, Eng.). J. Phys., A, 1: 213-23(Mar. 1968).

In a classical fluid, whose potential energy may be expressed in terms of a pair potential possessing a Fourier transform, the potential of average force $U(r_{12})$ is closely related to an ensemble average of the reduced density fluctuation $\Sigma_{j=3}^{N} \exp(-ik.r_j)$. A method is developed of evaluating this ensemble average, and the relationship of the latter to the three-particle distribution function is explained. The technique is applied to the electron plasma and $U(r_{12})$ is evaluated to second order in the standard plasma param-

eter $\epsilon = e^2k_D/k_BT$, a result which, though not new, is comparatively easily derived, and the importance of the correct normalization of the radial distribution function $g(r_{12}) = \exp\{-(U(r_{12})/k_BT)\}$ in this problem is stressed. The possibility of extending the results to values of ϵ where a series expansion is completely inappropriate is discussed. (auth) (UK)

24313 BEHAVIOUR OF SEPARATION CONSTANTS FOR FINITE GYROMAGNETIC PLASMAS. Bevc, V. Electron. Lett., 4: 58-9(Feb. 9, 1968).

It is shown that a recently published critique of a paper of the same title is in error. Ref. 1. (Bevc, C., "Behavior of separation constants for finite gyromagnetic plasmas," IEEE Trans. 1965, AP-13, pp.918–926 and 1966, AP-14, p. 388, p. 804). (auth) (UK)

24314 BROADENING OF SPECTRAL LINES OF HIGHLY EXCITED HYDROGEN ATOMS IN A PLASMA. Minaeva, L. A.; Sobel'man, I. I. (Lebedev Inst. of Physics, Moscow). J. Quant. Spectrosc. Radiative Transfer, 8: 783-90(Feb. 1968). (In Russian).

Particular attention was given to the $n \rightarrow n'$ transition between neighboring highly excited states under conditions in which radio emission lines from hydrogen atoms are seen in the emission spectra of nebulae. Electron broadening and ionic broadening were studied in impact approximation. Estimates of the width of the γ line were made on the basis of the linear and quadratic Stark effects; the linear Stark effect gives a broadening proportional to n^2 whereas the quadratic Stark effect produces broadening proportional to n^4. These theoretical calculations agree with the experimental results. (auth) (UK)

24315 RELAXATIONS OF THE OCCUPIED LEVELS OF HYDROGEN IN A HIGHLY EXCITED PLASMA WITH CONSIDERATION OF THE REABSORPTION OF RADIATION. Gordiets, B. F.; Gudzenko, L. I.; Shelepin, L. A. (Lebedev Inst. of Physics, Moscow). J. Quant. Spectrosc. Radiative Transfer, 8: 791-804(Feb. 1968). (In Russian).

Ionization and recombination in a hydrogen plasma were calculated and the part played by reabsorption examined. The results obtained are important for analysis of the radiation from a plasma whose parameters are subject to rapid fluctuations. (auth)

24316 RECOMBINATION, RADIATIVE ENERGY LOSS, AND LEVEL POPULATIONS IN NONEQUILIBRIUM CESIUM DISCHARGES. Norcross, D. W.; Stone, P. M. (Sperry Rand Research Center, Sudbury, Mass.). J. Quant. Spectrosc. Radiative Transfer, 8: 655-84(Feb. 1968).

The transition rate equations for the populations of cesium states in a homogeneous, optically thin plasma were solved for the excited-state populations, the effective ground-state ionization and recombination coefficients, and the effective electron kinetic-energy and radiative loss coefficients. A table of values is presented for the nonequilibrium steady-state plasma which is analogous to the Saha equation for the equilibrium plasma. Free electron densities from 10^{12} to 10^{15} cm^{-3} are considered, and a Maxwellian electron velocity distribution at temperatures from 1500 to 3000°K is assumed. These conditions are typical of those in thermionic and magnetohydrodynamic energy converters and other cesium discharges. The rate coefficients used for collision-induced and radiative atomic transitions are described. Molecular processes, diffusion, wall losses, etc., are discussed but not included explicitly in the model. The absorption of resonance radiation is simulated by reduction of the spontaneous emission coefficients. Other radiative absorption processes are neglected. The populations are seen to depart significantly from the Boltzmann distribution in steady state, and it is seen that many excited states participate in the ionization and recombination processes. The implications of these results for spectroscopic diagnostics, volume ion production, and energy loss in a cesium-discharge plasma are discussed. (auth) (UK)

24317 WAVE PROPAGATION IN COMPRESSIBLE ELECTRON–ION MAGNETOPLASMA. Talekar, V. L.; Rawat, S. S. (Malaviya Regional Engineering Coll., Jaipur, India). Int. J. Electron., 23: 253-62(1968).

Coupled wave equations have been developed for the propagation of electromagnetic, electron acoustic and ion acoustic waves in a homogeneous, warm magnetoplasma employing the linearized two-fluid continuum theory of partially ionized plasma dynamics. For the purpose of this study propagation is considered in a plane transverse to the static magnetic field. Coefficients occurring in the dispersion relation have been calculated for two-component electron–ion hydrogen magnetoplasma over a wide frequency spectrum, and these are used to study the dispersion relation in various frequency ranges. It is observed that the modified ion plasma mode propagates in the entire range of the frequency spectrum, but the electromagnetic mode, ordinary as well as extraordinary, and the electron-plasma mode propagate only in the range higher than the electron plasma frequency. (auth) (UK)

24318 EFFECT OF EXTERNAL RADIATIONS ON THE LEAKAGE TIME CONSTANT IN AN OZONIZER DISCHARGE AND THE ASSOCIATED JOSHI EFFECT. Arnikar, H. J. (Univ. of Poona); Kanitkar, P. L.; Mande, C. J. Phys., D, 1: 519-20(Apr. 1968).

The effect of external irradiation by visible light, x rays and γ rays on the leakage time constant τ in an externally excited dc discharge through hydrogen in a Siemens-type ozonizer was studied. It was observed that τ increased as a result of irradiation. The magnitude of the increase in τ, which depends upon the intensity as well as upon the frequency of the radiation, may be directly linked with the negative Joshi effect. (auth) (UK)

24319 EFFECT OF THE BULK GAS ON THE ELECTRICAL CONDUCTIVITY OF POTASSIUM-SEEDED NON-EQUILIBRIUM PLASMAS. Ellington, H. I. (Robert Gordon's Inst. of Tech., Aberdeen, Scotland). J. Phys., D, 1: 189-92(Feb. 1968).

Recently published experimental results of Ellington and Ralph, showing the effect of the diluent gas on the electrical properties of alkali-metal-seeded rare-gas plasmas, are discussed in terms of an extension of the two-temperature conductivity theory first proposed by Kerrebrock. The theory explains the increase in the plasma electric field required to maintain a given current when helium replaces argon as diluent, with potassium as seed, over the seed pressure range 0.1 to 40 torr (the factor of increase falls from about 13 to about 2 between these values). The gas pressure is atmospheric. Neon is shown to occupy an intermediate position between helium and argon. The theory developed is used to give an estimate, based on experiment, of the effect on K–He, K–Ne and K–Ar plasmas of varying the diluent pressure from 0.01 to 20 atmospheres. At low diluent pressures the electric field values required to produce a given current in the three mixtures converge and level out, while at high pressures they diverge and increase rapidly with rising pressure. At high pressures helium requires field values about 20 times as high as for argon, and neon about 4 times as high. It is concluded that argon and neon seeded with potassium (or cesium) appear to be suitable for use as the working fluid in a magnetohydrodynamic generator operating at pressures up to 10 or 20 atmospheres, but that helium appears to be unsuitable as a diluent at pressures above 2 or 3 atmospheres. (auth) (UK)

24320 NONLINEAR CROSS MODULATION OF ELECTROMAGNETIC WAVES IN A PLASMA DUE TO TIME-DEPENDENT ELECTRON DENSITY. Sodha, M. S.; Sawhney, B. K. (Indian Inst. of Tech., New Delhi). J. Phys., D, 1: 55-62(1968).

Expressions are derived for the time-dependent components of the electron density in a plasma subjected to an amplitude-modulated electric vector by assuming the electron density to follow the time-dependent (at modulation frequency) instantaneous changes in the electron temperature. These expressions for the time-dependent components in the electron density were used to investigate the various time-dependent components of the current density when another weak wave of frequency ω_1 is also propagating in the plasma; this expression for the current density was substituted in the appropriate wave equation and the solutions used to study the change in modulation of the strong wave (ω) and the cross modulation of the weak wave (ω_1) when reflected from a plasma–free-space interface, the wave being normally incident from the free space side. Some numerical calculations were carried out for the dependence of change in modulation and cross modulation in the reflected wave on relevant parameters by assuming the electron density to be governed by Saha's equation corresponding to the electron temperature; the results are presented in tabular form. (auth) (UK)

24321 MEASUREMENT OF THE STARK BROADENING PARAMETERS OF SEVERAL Ar II LINES. Roberts, D. E. (Imperial Coll. of Science and Tech., London). J. Phys., B, 1: 53-61(Jan. 1968).

The profiles of several electron-impact-broadened Ar II lines emitted by a high-density Z-pinch plasma were recorded using a rapid scanning Fabry–Pérot interferometer. The plasma electron density was determined by Fabry–Pérot interferometry in conjunction with a laser light source. Measurement of the relative intensity of an Ar III line and nearby Ar II line enabled the plasma temperature to be estimated. The measured Ar II linewidths are compared with those predicted by the impact approximation using straight-line perturber orbits and neglecting lower-state broadening. In all cases studied the ratio of experimental to theoretical linewidth was at least a factor of 2. The cause of these large discrepancies, and the implications of the results for other emitting species will be discussed in a subsequent paper. (auth) (UK)

24322 GUIDED WAVES ON COLD NONUNIFORM PLASMA COLUMNS. Briggs, R. J. (Massachusetts Inst. of Tech., Cambridge); Paik, S. F. Int. J. Electron., 23: 163-81(1968).

Some general features of the problem of guided waves on cold plasma columns in an axial magnetic field which are transversely nonuniform are examined. It is shown that a marked increase in the damping of the cold-plasma space-charge waves can occur in those frequency regions where a type of "resonance" exists in the plasma. Two specific examples are examined to illustrate the general ideas: plasma slab with a trapezoidal density distribution in the absence of a magnetic field, and a circular column with a parabolic density distribution in an axial magnetic field. The possible relevance of the general results to several experimental observations of an anomalously large damping of guided waves is discussed. (auth) (UK)

24323 UNIVERSAL KINETIC THEORY FOR WEAKLY IONIZED PLASMA IN TIME-DEPENDENT MAGNETIC FIELDS AND ADDITIONAL ELECTROMAGNETIC FIELDS. Stiller, Wolfgang (Deutsche Akademie der Wissenschaften, Berlin). Beitr. Plasmaphys., 7: 507-11(1967). (In German).

A general method is given for the calculation of the electron distribution function of a weakly ionized plasma in external time-dependent magnetic fields and additional electromagnetic fields. The Boltzmann equation of kinetic theory is solved taking into account elastic collisions between electrons and neutrals. The isotropic part f^0 of the distribution function follows from a general linear integro-differential equation and contains all known standard distributions (Druyvesteyn, Davydov, Margenau and others) as special cases. The direction-dependent part f^1 gives the transport tensors. (auth)

24324 OPERATOR METHOD FOR SOLUTION OF THE VLASOV EQUATION WITH BGK TERMS AND AN EXTERNAL ELECTRIC FIELD. Kolley, Winfried; Vojta, Guenter (Karl-Marx-Univ., Leipzig. Deutsche Akademie der Wissenschaften, Berlin). Beitr. Plasmaphys., 7: 513-21(1967). (In German).

Irreversible processes in a classical electron plasma are treated on the basis of a linearized Vlasov equation supplemented by Bhatnagar–Gross–Krook terms describing electron–electron and electron–ion collisions correctly. The infinitely extended plasma is under the action of a space- and time-dependent external electric field. A general method of solution with projection operator techniques is given which results in a system of two coupled Volterra integral equations of the convolution type for the internal electric field and the current density. From there follows the electron distribution function, the electric field in the plasma, the electrical conductivity and a very general dispersion relation including Landau and collision damping. The method given can be generalized for multicomponent plasmas and for strong external electric fields. (auth)

24325 ALKALINE PLASMAS IONISED BY CONTACT: LOW FREQUENCY PROPAGATION. Doucet, H. J. Onde Elec., 48: 264-7(Mar. 1968). (In French).

A brief survey is provided of the contributions of the alkali plasmas ionized by contact to the study of the physics of ionized media and, in particular, to the propagation of low-frequency waves. Experimental data relating to the recombination and the resistivity of the completely ionized gases are presented. Low-frequency wave propagation experiments are analyzed, more particularly in the case of the ionic pseudo-sound waves, in connection with which Landau damping and damping by collision are discussed. (auth)

24326 RAPID MAXWELLISATION OF AN ELECTRONIC GAS BY CONFINED ELECTRO-ACOUSTIC WAVES. Kettani, M.-A.; Hoyaux, M. F. (Carnegie Inst. of Tech., Pittsburgh). Onde Elec., 48: 251-63(Mar. 1968). (In French).

The hypothesis is developed according to which the maxwellization of an electronic gas results from the interaction between the ascending electronic beam and a group of space charge clouds engendered by the electro–acoustic waves confined in a plasma pocket and the constriction of a mercury vapor arc. Although based on a simplified model, the theory is in agreement with the results of observations. (auth)

24327 OBSERVATION OF AMPLITUDE OSCILLATIONS OF LARGE-AMPLITUDE ION ACOUSTIC WAVES IN A PLASMA. Sato, Noriyoshi; Ikezi, Hiroyuki; Yamashita, Yoshihiko; Takahashi, Nobuo (Nagoya Univ., Japan). Phys. Rev. Lett., 20: 837-9(Apr. 15, 1968).

Experimental results are reported on amplitude oscillations of large-amplitude ion–acoustic waves excited externally in a thermally ionized cesium plasma. Relative amplitudes are given as a function of the grid separation and the exciting signal. (M.O.W.)

24328 FERMI-LIQUID EFFECTS IN MAGNETOPLASMA MODES IN ALKALI METALS. Mermin, N. D.; Cheng, Y. C. (Cornell Univ., Ithaca, N. Y.). Phys. Rev. Lett., 20: 839-42 (Apr. 15, 1968).

The structure of the spectrum of long-wavelength plasma modes propagating perpendicular to the magnetic field is discussed. It is shown that the Landau–Silin kinetic equation for an isotropic, charged Fermi liquid does predict a quadratic small-k dependence for the resonant frequencies. (M.O.W.)

24329 PLASMA RESPONSE TO THE SUDDEN APPLICATION OF AN ELECTRIC FIELD. DeGroot, John S.; MacKenzie, Kenneth R. (Univ. of California, Los Angeles). Phys. Rev. Lett., 20: 907-8(Apr. 22, 1968).

Total current measurements were made in the xenon plasma. The electric field was induced by a toroidal transformer. (M.O.W.)

24330 STREAMING PLASMA TRANSPORT AND CUTOFF IN TRANSVERSE MAGNETIC FIELDS. Bernstein, W.; Ogawa, H. S.; Sellen, J. M. Jr. (TRW Systems Group, Redondo Beach, Calif.). Phys. Rev. Lett., 20: 903-5(Apr. 22, 1968).

The penetration of an annular plasma stream through a radial magnetic field is under investigation. Preliminary experimental results indicate that electron penetration of the magnetic field ceases as the magnetic field intensity is increased above a critical value where the electron cyclotron frequency ω_{ce} approaches the electron plasma frequency ω_{pe}. This nonpenetrating regime appears to be stable. For values of magnetic field below the critical value, high-frequency oscillations always, and low-frequency oscillations occasionally, are observed. (M.O.W.)

24331 INVARIANT IMBEDDING AND RADIATIVE TRANSFER IN SPHERICAL SHELLS. Bellman, Richard (Univ. of Southern California, Los Angeles); Kagiwada, Harriet; Kalaba, Robert. J. Comput. Phys., 1: 245-56(Nov. 1966).

The invariant imbedding equation for the reflection function of a spherical shell, in which absorption and isotropic multiple scattering processes take place, is a non-linear, partial differential integral equation. Two methods for its numerical solution are sketched, and the results of some numerical experiments are presented. (auth)

24332 EXCITATION OF ELECTROMAGNETIC WAVES ON A PLASMA COLUMN BY A RING SOURCE OUTSIDE THE PLASMA. Gupta, K. C.; Singh, A. (Central Electronics Engineering Research Inst., Pilani, India). Int. J. Electron., 23: 323-8(Oct. 1967).

Analysis for excitation of the circular symmetric E mode on columns of isotropic plasma by a ring source outside the plasma is reported. It is shown that slow waves can be excited with high excitation efficiency. (auth) (UK)

24333 ABSORPTION OF MICROWAVE RADIATION IN A SLIGHTLY IONIZED GAS. Wald, Leonard Howe. Ann Arbor, Mich., Univ. of Michigan, 1967. 151p.

Thesis.

The absorption of microwave radiation in a slightly ionized gas as a function of electron density was studied. Motivation was provided by the lack of interpretable microwave absorption data in the literature for the frequency range $.2 \leq \omega_p^2/\omega^2 \leq .8$ and the existence of three significantly different equations—Maxwell–Lorentz absorption equation, the classic transport equation, and the Klevans–Osborn transport equation—which have been used to predict microwave absorption in the above-mentioned frequency range. (Disser. Abstr.) (TSS)

24334 KINETIC EQUATION FOR A PLASMA AND ITS APPLICATION TO HIGH-FREQUENCY CONDUCTIVITY. Fu, Jerry Hui-ming. Ann Arbor, Mich., Univ. of Michigan, 1967. 102p.

Thesis.

A kinetic equation for an inhomogeneous and nonisotropic plasma is derived in the plasma limit. The treatment is based on the joint solution of the first two members of the BBKGY hierarchy, and on a linearization procedure about the unperturbed state. The unperturbed distribution functions, $f_0(\eta)$ and $g_0(\eta,\eta', \underset{\sim}{r}-\underset{\sim}{r}')$, are unspecified. Furthermore, the unperturbed pair correlation function, $g_0(\eta,\eta', \underset{\sim}{r}-\underset{\sim}{r}')$, is eliminated in favor of the unperturbed one-particle distribution function, $f_0(\eta)$. This elimination is accomplished by solving the equation for $g_0(\eta,\eta', \underset{\sim}{r}-\underset{\sim}{r}')$. The resulting kinetic equation is free from Bogolyubov's adiabatic hypothesis; therefore, it is valid for arbitrary frequency. In the limiting case when the frequency under consideration is much higher than the collision-frequency, a general expression for the high-frequency electric conductivity tensor is derived. From this general expression the results for the homogeneous and isotropic case previously derived by Klevans and Wu, as well as the results for the thermodynamic equilibrium case derived by Oberman, Ron, and Dawson can be recovered. (Disser. Abstr.)

24335 THEORY OF NONLINEAR MIXED FREQUENCY GENERATION IN AN ANISOTROPIC PLASMA. Hagenbuch,

Keith Marshall. University Park, Pa., Pennsylvania State Univ., 1967. 74p.

Thesis.

The Maxwell equations and the fluid equations for a plasma are expanded in a perturbation series to investigate nonlinear mixed frequency generation in a gyromagnetic medium. Neutral particles and ions are assumed to be fixed, collisions are neglected, and the Debye length is assumed to be small compared with the wavelengths of propagating radio waves. Using Fourier transforms the second order amplitudes are found and the mixed frequency energy per unit area generated by two monochromatic waves in a homogeneous slab of thickness Δz during the time interval Δt is calculated. This result is applied to the case when the interacting waves are not monochromatic and when the plasma is slightly inhomogeneous. (Disser. Abstr.)

24336 PROPAGATION IN WAVEGUIDES FILLED WITH WARM PLASMA. Nield, Philip W. Cleveland, Case Inst. of Tech., 1967. 183p.

Thesis.

The linearized equations describing the propagation of the normal modes in a plasma filled waveguide at microwave frequencies and in the presence of an axial constant magnetic field are derived from moments of the Boltzmann equation. Collisions are retained. For two cases where the plasma is assumed to be drifting but uniform or stationary but nonuniform in the transverse plane, it is possible to completely solve for the fields by solving a set of coupled equations for the axial electric and magnetic fields and the pressure. If the plasma is assumed to be stationary and uniform these reduce to a set of coupled Helmholz equations. Solutions for this case are considered in detail. The equations can be simplified considerably and cast into a form very similar to those used to describe wave propagation in a cold plasma. Solutions are obtained by employing an iterative technique. (Disser. Abstr.)

24337 WAVE INTERACTION IN NONRELATIVISTIC ELECTRON BEAM–PLASMA SYSTEMS. Otteni, Gerald Anthony. Cleveland, Case Inst. of Tech., 1967. 149p.

Thesis.

A theoretical model based on the linearization of the fluid equations and Maxwell's equations for wave interaction in a uniform plasma which is interpenetrated by a nonrelativistic electron beam is developed. The effects of electron–neutral and electron–ion collisions and temperatures of both the beam and plasma electrons are included and no quasi-static approximation is made for the electromagnetic field. An external dc magnetic field is assumed to act so that a general formulation is developed which is valid in the limit of small dc magnetic fields and in the limit as the field becomes very large. Graphs of the computer solutions are given for the propagation constants in a beam–plasma system for the cases of an unbounded system and for the TM wave solutions that may exist in an axisymmetric cylindrical system in which the finite beam interpenetrates an unbounded plasma. (Disser. Abstr.)

24338 STUDY OF ELECTROMAGNETIC WAVES IN A CIRCULAR PLASMA COLUMN. Berrett, Paul Orin. Salt Lake City, Univ. of Utah, 1965. 173p.

Thesis.

Electromagnetic waves in a circular plasma column with axial static magnetic field are investigated. The analytic approach to find the mode solutions treats the plasma as a medium having a tensor permittivity and introduces the boundary conditions as impedances at the column's lateral surface. It is found that, in general, the modes are hybrid and the usual separation into transverse electric and transverse magnetic modes is not possible. Solutions are found by solving the determinantal equation by numerical methods on a high-speed digital computer. Experimental measurements on a thermally generated cesium plasma column and on a mercury discharge plasma column are reported. (Disser. Abstr.)

24339 ON THE KINETIC THEORY OF THE LORENTZ GAS. Hoegy, Walter R. Ann Arbor, Mich., Univ. of Michigan, 1967. 175p.

Thesis.

A study is made of the nonequilibrium behavior of the classical Lorentz gas. The particle distribution is found to satisfy a dynamical equation that generalizes the Lorentz–Boltzmann equation. The first term in a density expansion gives the Enskog generalization of the Lorentz–Boltzmann collision integral. The analysis is carried out by expanding the system streaming operator in a cluster expansion and a Husimi-like expansion. Use of the binary collision allows an interpretation of the terms in the collision operators. The higher density collision operator terms are shown to diverge in the long time limit. The divergence is removed by a ring diagram technique, and a simple prescription is given for the general renormalized terms. A formula is obtained for the Lorentz gas conductivity using the renormalized collision operator. The one dimensional Lorentz gas particle distribution is completely evaluated. Renormalized and unrenormalized calculations are carried out for the wind-tree and the hard disks models, and the nonanalyticity of the latter model is exhibited. (Diss. Abstr.)

24340 PROPAGATION AND REFLECTION OF THE LOSS-CONE MODE IN AN INHOMOGENEOUS PLASMA. Horton, Claude Wendell Jr. San Diego, Calif., Univ. of California, 1967. 103p.

Thesis.

The dispersion relation for the loss-cone mode of Post and Rosenbluth is reviewed, and the physical characteristics of the mode are discussed. The dispersion relation is then solved for the growth length of the instability including the effects of finite electron temperature. A critical length for the confinement of the plasma is calculated by assuming that the waves are completely absorbed at the ends of the mirror machine. The propagation and reflection of the electron plasma wave which forms the basis of the loss-cone mode is considered in an inhomogeneous plasma by means of the Wentzel–Kramers–Brillouin method. The plasma wave functions are obtained to the first order in the WKB expansion parameter. The reflected wave is derived from the second order terms in the WKB expansion, and the reflection coefficient is given. From the reflection coefficient two physical processes for the reflection of plasma waves are identified. The reflection due to scattering of the incident wave off the local density gradients is calculated in detail and is found to consist of two types of terms. One term is the same as that obtained from solving the problem in the fluid approximation; the remaining terms depend upon the thermal properties of the plasma for their existence and dominate for a hot plasma. The importance of reflection for the loss-cone instability is discussed. The reflection coefficient is applied to the loss-cone instability to obtain stability criteria for absolute growth in the unstable mode under various conditions. For the linear potential the plasma wave equation is reduced to an integral equation with a displacement kernel. A convergent iterative method for solving the integral equation is constructed with the knowledge of a convergence criterion which is developed from a local Fourier transform of the operators involved. The wave solutions for a set of parameters are given and compared with the WKB solutions. The numerical solutions are decomposed into left and right traveling waves, and the reflection coefficients are obtained. The reflection coefficients obtained from the numerical solutions agree with those given by the lowest order WKB theory and also exhibit the transition between the fluid and thermal reflection mechanisms. (Diss. Abstr.)

24341 NONLINEAR OSCILLATIONS IN A MAXWELLIAN PLASMA. Gary, Stephen Peter. St. Louis, Washington Univ., 1967. 70p.

Thesis.

A theory of nonlinear plasma oscillations in a classical, nonrelativistic, collisionless, Maxwellian electron gas of finite extent is discussed. Both longitudinal and transverse waves are studied by considering the initial value problem for certain initial perturbations of order ϵ. The nonlinear Vlasov equation is solved to second order in the long time limit, and the spatially homogeneous part of the distribution function is then included as an iterative correction to the linear theory. For longitudinal oscillations this second order correction is shown to be significant for many values of ϵ and wavenumber, and in the long time limit can lead to a reduction in magnitude of the damping decrement. Thus some of the results of Knorr and Armstrong, obtained by numerical integration of the nonlinear Vlasov equation, are explained. In the case of transverse oscillations, the nonlinear correction drives the least damped linear damping decrement even more negative, thereby precluding observation of the effect in this case. (Diss. Abstr.)

24342 PROBLEMS IN MACROSCOPIC AND KINETIC PLASMA THEORY. Perona, Giovanni Emilio. Ithaca, N. Y., Cornell Univ., 1967. 121p.

Thesis

The first section is a study of normal ionizing shock waves. After a preliminary review of some of the work done in this field, the shock equations are integrated for a very simple model. Diagrams describing the shock structure for different initial values are given, and the main features of the structure are discussed. As a physical example the equations governing the shock structure for argon were integrated. It is shown that the results of these calculations justify the use of the main assumptions made in deriving the equations. The results of the numerical integration are displayed. The second section is a study of the BBKGY equations. These equations are written in nondimensionalized form, leaving two parameters, α and β, explicit. The s-particle distribution function is expanded about vanishing correlation with ϵ entering as a parameter of smallness. Nine cases are considered depending on the order of magnitude of α and β (viz., ϵ, 1, ϵ^{-1}). It is shown

that the lowest order terms, in each of the cases considered, give a kinetic equation together with subsidiary conditions. A critical survey is made of the compatibility problem, which is inherent to expansions of the BBKGY sequence. (Diss. Abstr.)

24343 EXPERIMENTAL INVESTIGATION OF ELECTRON RUNAWAY PHENOMENA. DeGroot, John Stacey. Los Angeles, Univ. of California, 1967. 93p.

Thesis.

An experiment is reported in which the dynamic response of a gaseous plasma to the sudden application of a strong electric field is measured. The plasma is produced by photo-ionization of xenon gas. The photons are generated over a period of about 3.5 microseconds by a vacuum spark driven by a 500-joule capacitor bank. The initial fractional ionization is about 1% in xenon. Langmuir probes were used to measure the plasma properties. A one-to-one turns ratio transformer is used to induce the electric field in the plasma. The plasma is the secondary of the transformer. In this way the total current which flows in the plasma is easily measured, since current flowing in the secondary of the transformer is reflected into the primary. The difference in the current in the primary with and without plasma is just the current in the plasma. A current probe is also used to measure the drift velocity of the electrons in the central region of the plasma. In agreement with the theory, ion-acoustic waves are found to be spontaneously excited in the plasma. A Langmuir probe was used to measure the density fluctuations, and a new high-impedance probe was constructed to measure the associated potential fluctuations. (TSS) (Disser. Abstr.)

24344 COLLISIONAL DAMPING OF WAVES IN AN ELECTRON PLASMA. Mukerjee, Hari Gopal. Columbia, Mo., Univ. of Missouri, 1967. 68p.

Thesis.

Collisional damping of longitudinal waves is calculated for an electron plasma. The Coulomb interactions are treated by the BBGKY theory. The hierarchy of equations is truncated by neglecting the triplet correlation. The resulting set of equations is linearized about an equilibrium Maxwellian distribution. Using an operator technique the equation for the pair correlation is solved in terms of one-particle distribution functions, and a kinetic equation is obtained. A dispersion relation for the wave is derived from the kinetic equation, and the collisional damping decrement has been calculated. The temperature-dependent correction to the oscillation frequency is found to be small. Expanded to the lowest significant order of the wave number, the collisional damping is found to be proportional to the square of the wave number. Although Landau damping is dominant at short wavelengths, collision is found to be the dominant mechanism for damping at long wavelengths. (Disser. Abstr.)

24345 EXPERIMENTS ON THE NONLINEAR BEHAVIOR OF PLASMAS. Ajmera, Ramesh Chand. Iowa City, Iowa, Univ. of Iowa, 1967. 90p.

Thesis.

Detailed design considerations for mercury vapor discharge plasma tubes are given. Various microwave techniques are also presented. A discussion of the coupling from transverse to longitudinal waves via the Tonks-Dattner resonances is presented. Two recent experiments of Stern and Tzoar concerning the nonlinear interaction of two waves in a plasma are extended to experimentally demonstrate that propagating surface waves can be launched through either nonlinear mechanism. In addition a dispersion curve is measured for these waves. A second experiment demonstrates that the zeroth order distribution function can be modified with a relatively small amount of incident power irradiating a plasma column. (Disser. Abstr.)

24346 SELF-CONSISTENT ANALYSIS OF THE ELECTRON DISTRIBUTION FUNCTION AND ATOMIC STATE DENSITIES IN A PLASMA. Cohn, Arthur. Troy, N. Y., Rensselaer Polytechnic Inst., 1967. 306p.

Thesis.

The escape of resonance radiation from a plasma, forces an imbalance between the inelastic and superelastic collision rates. The effect of this imbalance, on the electron distribution function and the atomic state densities, is analyzed self-consistently. The basic parameters taken as given, are: the electron density and average energy, and the proportion of resonance radiation escape. The parameters solved for are: all the atomic state densities, and the electron distribution function. It is found, that the densities of the excited atomic states, can be approximately calculated independently of the specific form of the tail of the distribution function. It is shown that it follows that the magnitude of the "gain" function at the excitation energy of the ground state, E_x, is also approximately independent of the form of the tail of the distribution function, and can be calculated prior to the main solution procedure. This gain magnitude provides the boundary condition that allows the kinetic equation to be solved for the distribution function, the gain function, as well as the ground-state density as the eigenvalue. The forms of the distribution function found are: closely Maxwellian at energies below $8T_e$; the Maxwellian form minus a slightly varying defect term, which is proportional to the gain magnitude, from $8T_e$ to E_x; then a form that asymptotes into an approximately constant fraction of the original Maxwellian's form at energies above E_x, this fraction being proportional to the ratio of the second-state's density to the ground-state's density. Numerical calculations that partly illustrate the self-consistent procedure are described. The excited state densities are solved and tabulated, for a wide range of electron density and degrees of radiation escape, at $T_e = 8000°K$. An approximate formula for the ground-state density is also developed, and the results tabulated. The physical conditions for which a Maxwellian distribution applies are analyzed, and a simple procedure is described for determining them. (Disser. Abstr.)

24347 KINETIC THEORY OF FORCED OSCILLATIONS IN PLASMAS. Massel, Gary Alan. Raleigh, N. C., North Carolina State of the Univ. of North Carolina, 1967. 230p.

Thesis.

The kinetic theory of forced oscillations in plasmas is developed with emphasis on examining both the collective properties and the streaming properties of the system. The streaming properties play no role in free oscillations; however, they are frequently a dominant contribution in forced oscillations. Considering forced oscillations necessitates taking the effect of an external source into the theory. The theory is developed and applied to three plasma models, describing both collisionless and collisional propagation. One of the plasma models describing the transition from collision dominated to collisionless propagation of ion-acoustic waves has been used for the first time in this application and the theoretical description is in good agreement with experimental results. The techniques which are developed are also applied to the problem of neutron diffusion using a modulated neutron source. Computer experiments are developed for one-dimensional N-body systems and used to study the fluctuations of plasmas. Very good agreement is obtained between the results of the experiment and the theory for both the static and the dynamic aspects of the correlations. Verification is obtained for the existence of the streaming modes and for the diffusional damping of the autocorrelation function. Relating the correlation properties to the plasma impedance, the validity of the derivation of the impedance for a grid pair immersed in a plasma is examined. (Disser. Abstr.)

24348 NEGATIVE POINT TO PLANE BREAKDOWN IN A FREE ELECTRON GAS. Hassoun, Abbass Mohd. Berkeley, Calif., Univ. of California, 1967. 43p.

Thesis.

It has been indicated by Loeb in 1949 that a highly stressed cathode in asymmetrical fields in free electron gases at threshold would go directly to transient power arc via a spark-like mechanism with no antecedent corona. Using an outgassed W point cathode in a 4-cm point-to-plane gap in pure He admitted under Alpert vacuum techniques, the breakdown was studied from 50 to 220 Torr as a function of steady potentials from appropriate capacities The potential range was limited by the minimum measurable luminosity and by the danger of point damage above currents leading to hot cathode arc. Currents ranged from 10^{-4} A to amperes at peak. By appropriate electronic techniques with a dual-beam oscilloscope, current-potential, current-photomultiplier traces of luminous phenomena that crossed a slit transverse to the arc at various points in the gap, and potential-photomultiplier traces were observed as a function of time. The traces were observed with full luminosity as well as through two filters which distinguished field-conditioned excitation and thermal excitation. Still photographs yielded maximum arc channel radii which, in turn, gave channel current densities and ambipolar diffusion during current rise. Breakdown started as a Townsend γ_p and later went to a γ_i conditioned discharge at the cathode. The current rose hyperexponentially and then exponentially until current drain reduced the potential on the capacity. The currents observed drew about one third of the stored charge. Luminosity rose slightly more rapidly than current. This luminosity projected outward as a bright pulse of about gap-length width. The observed excitation pulse rose rapidly and declined before current peak except at the highest potentials. The arc pulse rose with the current but persisted after current decline. At a given pressure current densities were constant and peak potentials down the arc channels yielded potential gradients which were the same. Photomultiplier traces indicated current oscillations of 7×10^7 cycles/sec, which were independent of external circuitry or currents. These were ascribed to ion plasma oscillations across the constant cathode fall region with plasma densities of 4.5×10^{11} carriers/cm^3. These oscillations are a consequence of a more rapid electron generation than the rate of removal by the field. The luminous pulse peak repre-

sented an ionizing and exciting potential gradient at the tip of the electron swarm that crossed the gap at from 4×10^6 to 1×10^8 cm/sec. The speed was that to be expected of electrons due to the field across the gap. The estimated charge density in the channel was of the order of 10^{14} ions/cm^3 and possibly somewhat less. The high carrier density in the arc channel arose from initial ionization along the growing arc channel. Because of the small diffusion and thermal expansion there was created a small arc channel diameter which funneled the plasma density of 3×10^{11} electrons/cm^3 from the extensive cathode glow discharge surface area. Such a funneling assumes that the active cathode glow surface yielding 4.5×10^{11} carriers/cm^3 was of the order of 0.17 cm^2 which is a reasonable order of magnitude for the observed glow area. (TSS) (Disser. Abstr.)

24349 ION OSCILLATIONS IN AN ELECTRON BEAM GENERATED PLASMA. Christie, Joseph William. Stanford, Calif., Stanford Univ., 1967. 141p.

Thesis.

Oscillatory phenomena associated with an electron beam passing through partially ionized, low-pressure gas were studied. Three distinct physical regimes were defined, namely: the very-low-pressure regime where the residual ion density is a negligible fraction of the electron beam charge density, the low-to-moderate-pressure region where the residual ion density is a significant fraction or even equal to the electron beam charge density, and the third regime where the moderate gas pressure allows the ion density to be equal or significantly exceed the electron beam charge density. In those regions where the ion density is significant various workers have observed the presence of low frequency, typically in the megacycle region, oscillations in the electron beam current. These oscillations have been generally assumed to be associated with the ion system and appeared to be motions where the charged particles moved in a predominantly perpendicular direction to the electron beam drift direction. It was the principal goal of this work to obtain a theoretical and experimental explanation of this often-observed phenomenon. (TSS) (Disser. Abstr.)

Production of Plasma

24350 (WERL-3472-9) PLASMA PRODUCTION BY A HIGH-POWER Q-SWITCHED LASER. Final Report, February 1, 1967–January 31, 1968. Engelhardt, A. G.; George, T. V.; Hora, H.; Pack, J. L. (Westinghouse Research Labs., Pittsburgh, Pa.). Mar. 7, 1968. Contract AT(30-1)-3472. 59p. Dep. CFSTI.

The focused output beam of a Q-switched ruby laser having a power of 150 MW and a total energy of 3 joules has produced plasmas from isolated single aluminum spheres 50 to 150 μ in radius. Before being struck successfully, each target was positioned in the vacuum system by an electromagnetically operated retracting pedestal system. In the present pedestal design the diameter of the obstacle-free region can be as large as 21 cm. The technique can be extended to larger ultra-high-vacuum systems. Between 30 and 50% of the incident laser energy was absorbed by the plasma. Framing camera pictures taken at times up to 0.9 μsec show two luminous shells—an inner spherically symmetric core and an outer ring expanding more rapidly and slightly asymmetrically back toward the laser. The behavior of the outer shell, which contained ions having energies up to 5 keV and less than 1% of the plasma, is consistent with a theoretical model based on the nonlinear collisionless interaction of laser light with inhomogeneous plasma. The behavior of the inner core, which contained almost all of the plasma, is consistent with a thermodynamic equilibrium theory. For a target 50 μ in radius, the outermost ions of this core had an energy of 500 eV. The average energy of the core ions, decreased from 200 eV/Al atom for a 50-μ target to 20 eV/Al atom for a 120 μ target. Studies using a 70-GHz microwave interferometer show that the expansion velocity of the "cutoff" density front was 5×10^8 cm-sec^{-1} between 0.2 and 0.8 μsec in agreement with theory, and that the average electron density decreased from 1.4×10^{11} cm^{-3} at 4 μsec to 6×10^{10} cm^{-3} at 6 μsec. (auth)

24351 (AD-666155) STREAM EMISSION OF METALLIC PLASMA IN A VACUUM. Chekalin, E. K.; Shumanov, V. S. Translated from pp 101-8 of Issledovaniya po Fizicheskoi Gazodinamike, Izdatel'stvo, Nauka, Moscow, 1966. 12p. (FTD-MT-24-153-67). CFSTI.

In order to obtain streams of a metal plasma, use was made of the evaporation of the substance of the electrodes in a pulsed high-current discharge, followed by electrodynamic acceleration of the plasma formed. Analysis of the emission spectrum of the plasma in the visible region by means of an ISP-51 spectrograph showed the presence of the lines of the alkali metal employed, two hydrogen lines (H_α and H_β), and two lines of copper and sodium. Oscillograms of the glow intensity of the various spectral emission lines showed the plasma stream to be made up of individual plasmoids corresponding to the periodic ejections of plasma from the plasma gun. Some time-averaged parameters of the plasma streams of the alkali metal were measured: the concentration of ions $\bar{n}_i$ was found to be 4.0×10^{14} particles/cm^3, and the average temperature of the plasma stream $T_i = (19 \pm 5) \times 10^3$ °K. The average pressure in the plasma stream was found to be 1.6 mm Hg. It is shown that the averaging of the plasma parameters over a time interval of 100 μsec is fully justified: the experimentally determined average values of the plasma parameters should then be close to the true values. The study of the discharge of a metal plasma into a vacuum shows that such plasma jets can be used for investigating processes of heat transfer from the plasma stream to a solid wall and for various aerodynamic studies in plasmas. (auth)

24352 STUDY BY DOPPLER EFFECT OF EXPANSION OF A MICROPLASMA. Breton, Claude; Capet, Maurice; Courbin, Christine (EURATOM–CEA, Fontenay-aux-Roses, France). Compt. Rend., Ser. A and B, 266: 52-5(Jan. 8, 1968). (In French).

A microplasma is produced by irradiation of a lithium hydride particle ($\phi = 20$ μ) with a pulsed ruby laser. The granule is suspended in vacuum by an electrostatic procedure and the plasma resulting is released freely. The line widths emitted by this plasma was measured. The interpretation uses the A. F. Haught expansion model. It was deduced that each species of particle (H and Li) attains almost the same average velocity. (tr-auth)

24353 NATURE OF ELECTRON-FLUID-DYNAMICAL WAVES. Shelton, G. A. Jr.; Fowler, R. G. (Univ. of Oklahoma, Norman). Phys. Fluids, 11: 740-6(Apr. 1968).

A one-dimensional, inviscid, multifluid model is employed to describe a constant velocity, steady-profile, ionizing electron-fluid-dynamical wave propagating into a pure atomic gas subjected to an applied electric field E_0. It is demonstrated that the electron-fluid equations can be decoupled from the remaining equations allowing description of the wave in terms of electron variables only. Wave speed and resultant degree of ionization are derived as functions of applied field and initial gas pressure. Certain limiting conditions governing the existence of such steady-profile waves and comparison with the experimental work on breakdown waves are also presented. (auth)

24354 AN INTENSE RADIATION SOURCE BELOW 800 A FOR PREIONIZATION OF HYDROGEN FOR USE IN THETA PINCH EXPERIMENTS. I. Hofmann, G. (Institut fuer Plasmaphysik, GmbH, Garching, Ger.). J. Quant. Spectrosc. Radiative Transfer, 8: 729-34(Feb. 1968). (In German).

A light source was developed which emits a very intense short radiation pulse below 800 Å. With this device, molecular hydrogen could be ionized sufficiently to be used as the initial plasma for a theta pinch experiment. This light source is a fast high-voltage z-pinch which is filled dynamically, only for the duration of the ionizing light pulse, with dense lithium vapor. The electron density of the photoionized hydrogen was measured with a microwave interferometer, and the electrical conductivity was determined from the skin effect. In the middle of a tube 150-cm long and 4 cm in radius, a degree of ionization of 4.5% could be achieved (initial pressure 0.01 torr) using a light source at each end. The conductivity is so high that a magnetic field of 500 kHz penetrates only 0.5 cm. The electron temperature was found from the conductivity to be a few eV. (auth) (UK)

24355 EMISSION OF DENSE HELIUM AND HYDROGEN PLASMAS AND THEIR CONTRIBUTION TO THE PHOTOIONIZATION OF MOLECULAR HYDROGEN. II. Hofmann, G.; Pecorella, F. (Institut fuer Plasmaphysik, GmbH, Garching, Ger.). J. Quant. Spectrosc. Radiative Transfer, 8: 735-53(Feb. 1968). (In German).

In order to preionize the neutral hydrogen or deuterium gas of a theta pinch it is very useful to have an intense radiation source below 800 Å. The best kind of emitting plasma, and its optimum density and temperature are discussed. The spectra of dense helium and hydrogen plasmas in a spherical geometry for a fixed total power input were calculated and the efficiency below 800 Å was investigated. At lower densities the helium lines make a large contribution to the photoionizing radiation, but the lost internal energy of such an emitting plasma is rather high. At higher densities, the continuum makes the largest contribution, and the internal energy and the radius of the emitting plasma become very small. Hydrogen is always more efficient than helium, and its optimum temperature is not so critical as that of helium. The electron temperature of the photoionized hydrogen was calculated as a function of the temperature of the emitting plasma for an optically thick and optically thin source. (auth) (UK)

24356 NONEQUILIBRIUM RADIATION AND IONIZATION IN SHOCK WAVES. Chapin, Claire Edwin. Lafayette, Ind., Purdue Univ., 1967. 141p.

Thesis.

Radiation energy transfer and ionization rates in the mixture of atoms, ions, and electrons produced by a normal shock wave propagating in cold argon gas are examined. It is shown the gas may be regarded as a combination of two gases, one composed only of electrons and one composed of both atoms and ions. Temperature differences between the electron gas and the atom–ion gas significantly affect radiation and ionization rates in the shock wave. The analysis uses the ionization rates due to both atom–atom collisions and electron–atom collisions. In addition, photoionization, which is responsible for precursor ionization, is included. Although argon is not a grey gas, it is shown that the radiation variables may be reduced to the forms they would have if the gas were grey, but with different source functions and attenuation properties. Radiation generated by photoionization and radiative recombination involving excited atomic states escapes ahead of the shock wave and results only in cooling the hot gas. Radiation due to photoionization and recombination involving the ground state is trapped by the cold particles ahead of the shock and causes precursor ionization. Photoexcitation processes (line radiation) are omitted from consideration. The integral form of the radiation variables causes the equations to be integro–differential. Iterative techniques for solving the equations are not practical because they converge too slowly. Instead, a combined perturbation–iteration method is used. The effect of viscosity and heat conduction is to discontinuously change the temperature and density of the gas. Preceding the discontinuity is the precursor region, caused by ground state photoionization. After the discontinuity the electron gas is colder than the atom–ion gas. Subsequently the electron gas temperature increases until it becomes equal to the temperature of the atom–ion gas. Finally, after chemical equilibrium has been reached, the gas radiatively cools to its final state. The ionization rate and precursor ionization are found to be greatly affected by the cool layer of electron gas following the discontinuity. Radiation energy transfer has little effect on the ionization rate until equilibrium ionization is approached. The collisional rates then decrease and the radiative rates become relatively more important. The net effect is to decrease the ionization rate and delay chemical equilibrium. (Disser. Abstr.)

Stability of Plasma

24357 (MATT-Q-25, pp 223-38) WAVES AND STABILITY. (Princeton Univ., N. J. Plasma Physics Lab.).

Theoretical research results are presented for each of the following: (1) the resistive interchange and resistive ballooning modes in the stellarator, (2) quadratic form for collisional drift waves, and (3) resistively modified hydromagnetic modes in an inhomogeneous incompressible plasma. (M.O.W.)

24358 (UCRL-50397) FINITE β STABILIZATION OF ABSOLUTE LOSS-CONE INSTABILITIES. Pearlstein, L. D. (California Univ., Livermore. Lawrence Radiation Lab.). Mar. 12, 1968. Contract W-7405-eng-48. 10p. Dep. CFSTI.

The effect of finite β on absolute loss cone instabilities is calculated. It is shown that this addition tends to stabilize these modes. Limiting stable harmonics are presented for parameters in the thermonuclear regime. (auth)

24359 HELICAL INSTABILITY OF A HOLLOW PLASMA COLUMN IN A MAGNETIC FIELD WITH SHEAR. Reynolds, J. F.; Holt, E. H. (Rensselaer Polytechnic Inst., Troy, N. Y.). J. Appl. Phys., 39: 2360-2(Apr. 1968).

The theory of the helical instability of the positive column has been generalized to include the case of a magnetic field with shear. The resultant stability criterion has been evaluated numerically. It predicts stabilization when the sense of the helical magnetic field opposes that of the helical density perturbation of the instability. This has been verified by an experiment in a hollow plasma column. The radial form of the density of the unperturbed plasma is required for the calculation and has been obtained by both theoretical and experimental methods. (auth)

24360 LOW-FREQUENCY LIMIT OF INTERCHANGE INSTABILITY. Rosenbluth, Marshall N. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Phys. Fluids, 11: 869-72(Apr. 1968). (GA-8177).

It is shown under a wide range of conditions that if any mirroring particles in an axisymmetric toroidal confinement system have a time-averaged unfavorable drift then a low-frequency localized instability can result. An example of a geometry in which all particles have time-averaged favorable drift is given. (auth)

24361 NONLINEAR EVOLUTION OF A RESONANT INTERCHANGE MODE. Pearlstein, L. D. (Gulf General Atomic Inc., San Diego, Calif.). Phys. Fluids, 11: 873-82(Apr. 1968).

A resonant instability due to the presence of a small number of superthermal particles with an adverse spatial gradient in a hydromagnetically stable well configuration is examined. It is found that resonant diffusion leads to a stable quasilinear plateau in the distribution function. Wave scattering redistributes the wave spectrum from the linearly unstable region to a region of lower wavenumber, at the same time transferring energy to the particles. The nonlinear wave particle scattering leads to a diffusion equation in which only electrons can interact resonantly. In addition, there is a nonresonant contribution to diffusion due to the adiabatic response of electrons and ions to the time changing wave spectrum after stabilization. The net result is that ions and electrons diffuse at an equal rate with no charge separation developed. (auth)

24362 HIGH-FREQUENCY FLUTE-LIKE INSTABILITIES IN MULTICOMPONENT PLASMAS. Farr, W. M.; Budwine, R. E. (Oak Ridge National Lab., Tenn.). Contract W-7405-eng-26. Phys. Fluids, 11: 883-4(Apr. 1968). (ORNL-P-3377).

Detailed calculations have been made to determine thresholds for flute-like instabilities in a plasma containing both cold and hot, mirror-confined ions. The effect of a density inhomogeneity on these thresholds is also considered. (auth)

24363 INHOMOGENEOUS TWO-STREAM INSTABILITY. Knorr, Georg (Univ. of California, Los Angeles). Phys. Fluids, 11: 885-90(Apr. 1968).

It is shown that the well-known two-stream instability can under certain conditions be stabilized by the introduction of a periodic stationary electrostatic potential which is produced by the particle beams themselves. (auth)

24364 THEORY OF COLLISIONLESS-PLASMA DRIFT MODE IN MULTIPOLES. Jukes, J. D.; Rohlena, K. (United Kingdom Atomic Energy Authority, Abingdon, Eng.). Phys. Fluids, 11: 891-3(Apr. 1968).

A particle mode of drift/acoustic wave is considered in collisionless plasma in a closed multipole confining field. Stability criteria and the anomalous diffusion time of unstable plasma are estimated. (auth)

24365 EQUILIBRIUM OF TOROIDAL HIGH-β PLASMAS. Yoshikawa, S. (Princeton Univ., N. J.). Phys. Fluids, 11: 893-5(Apr. 1968).

A toroidal theta-pinch magnetohydrodynamic equilibrium configuration of a diffuse boundary is calculated analytically for $\beta = 1$ plasma. Equilibrium can be obtained even if the toroidal magnetic field is present, provided that the ratio, toroidal field over poloidal field, is less than the square root of the aspect ratio. (auth)

24366 TWO NEW RESULTS IN CYLINDRICAL DIOCOTRON THEORY. Levy, R. H. (Avco-Everett Research Lab., Everett, Mass.). Contract AT(30-1)-3863. Phys. Fluids, 11: 920-1(Apr. 1968). (NYO-3863-2).

Two new results on the diocotron wave are presented. One is a linearized solution valid for arbitrary unperturbed density profiles, but restricted to the fundamental mode. The other exhibits a special family of exact nonlinear solutions to diocotron-type motion. (auth)

24367 MICROINSTABILITIES AND DIFFUSION PROCESSES IN A THERMAL PLASMA. Porkolab, Miklos. Stanford, Calif., Stanford Univ., 1967. 213p.

Thesis.

Theoretical and experimental evidence indicates that oscillations due to small-scale instabilities may produce considerable turbulent diffusion. Because excessive turbulent diffusion would prevent the achievement of controlled thermonuclear fusion, it is of importance to know the rate at which plasma diffusion across magnetic field in the presence of random electric fields. The experiments are carried out in a thermally produced cesium or potassium plasma, confined by a magnetic field. Three kinds of microinstabilities are studied, namely the electrostatic ion cyclotron instability, the universal instability, and a new kind which is called a magnetoionic sound wave. The main contributions of the present work to the understanding of these instabilities are the following: for ion cyclotron waves, the dispersion relation is obtained utilizing wave propagation experiments. It is shown theoretically that damping due to ion–ion collisions would account for some of the experimental results. For the universal instability, the possibility of stabilization by the finite length of the plasma column is demonstrated both experimentally and theoretically. Magnetoionic sound waves are studied experimentally and theoretically, and it is shown by an extensive computer analysis that they may be manifestations of ion temperature gradient instabilities. For the sake of completeness, a comprehensive theoretical treatment of wave motion in a fully ionized, magnetized plasma is given, including collisions. The treatment is based upon kinetic theory, and is valid for arbitrary values of the Larmor radius. Results appropriate to the

foregoing instabilities are derived and discussed. In the last part of this work, the effect of turbulence upon diffusion is studied. The turbulent state is produced by (i) drift waves, excited by an axial dc current; (ii) injected coherent signals; and (iii) injected broadband noise. Diffusion is found to be directly proportional to the rms amplitude of oscillations, and inversely proportional to the magnetic field intensity. The effect of the oscillation spectrum upon diffusion is also studied. Finally, some numerical estimates are made and compared with Bohm diffusion. (TSS) (Disser. Abstr.)

Shielding

Refer also to abstract 23259.

24368 (LA-3573(Suppl.)) THE PROGRAM QAD V FOR CALCULATION OF VOLUME HEATING. Streetman, J. R. (Los Alamos Scientific Lab., N. Mex.). Apr. 1967. Contract W-7405-eng-36. 16p. Dep. CFSTI.

A FORTRAN program, QAD V, is described, by which heating of a volume of material subjected to gamma radiation from a volume source may be computed. The source volume is represented by an assembly of source points, and a shadow plane behind the volume being heated is tilted with rectangles. Heating along the path from each source point to the center of each rectangle is computed, and a properly weighted sum gives the volume heating. (auth)

24369 (PINSTECH/PHY-9) SELECTION OF LEAD FOR GAMMA-RAY SHIELDING AND IN-PILE COLLIMATION. Najam, M. R.; Khan, Z. U.; Ahmed, N. M. (Pakistan Inst. of Nuclear Science and Technology, Islamabad. Nuclear Physics Div.). Aug. 1967. 12p. Dep.

A discussion is given on the selection of an appropriate lead sample for gamma-ray shielding and in-pile collimation. Experiments were made to choose the proper lead for gamma shielding and for the neutron-capture gamma-ray facility, using activation analysis method. The rabbit system, an experimental facility of the Pakistan Research Reactor (PARR), was used for irradiation of the samples. Finally, bulk activities as well as activities under peaks of different samples were compared for the selection. The lead of Canadian and Australian origin was found to be the most suitable. (auth)

24370 MEASUREMENTS OF 6 MV X RAYS. I. PRIMARY RADIATION ABSORPTION IN LEAD, STEEL, AND CONCRETE. Karzmark, C. J.; Capone, Tatiana (Stanford Univ., Palo Alto, Calif.). Brit. J. Radiol., 41: 33-9(Jan. 1968).

Narrow and broad-beam absorption coefficients were evaluated for lead, steel, and concrete using the primary ray beam from a 6-MeV linear accelerator. For narrow beams the absorption coefficients in cm^{-1} are 0.50, 0.31, and 0.084 for lead, steel, and concrete, respectively, while the corresponding tenth-value thicknesses are 4.6, 7.5, and 27.4 cm, respectively. For broad beams the absorption coefficients in cm^{-1} are 0.41, 0.23, and 0.066 for lead, steel, and concrete, respectively, while the corresponding tenth-value thicknesses are 5.7, 10.0, and 34.8 cm, respectively. Measurements were made over six tenth-value thicknesses of lead and four to five for steel and concrete. Frequently, leakage and unwanted scatter are larger than the transmitted primary intensity by factors of 5 or greater. The methods of preferentially shielding and discriminating against these spurious components and the corrections for them are described. The attenuation curves, the experimental arrangements, and the problems of measurement are discussed. (auth)

24371 PROPERTIES OF A USEFUL BIORTHOGONAL SYSTEM. Spencer, L. V.; Flusser, P. J. Res. Nat. Bur. Stand., 71B: 197-211(Oct.-Dec. 1967).

In radiation penetration theory, infinite medium flux distributions have for some years been calculated using biorthogonal functions called $U_n^k(z)$. The spaces spanned by these functions, transformation kernels, generating functions, recursion relations, asymptotic trends for large n, many expansions, and relations with well-known orthogonal polynomials are worked out. (auth)

24372 CALCULATION OF THE PENETRATION OF GAMMA RAYS THROUGH SLABS BY THE METHOD OF INVARIANT IMBEDDING. Shimizu, A. (National Bureau of Standards, Washington, D. C.). Nucl. Sci. Eng., 32: 184-94(1968).

The method of invariant imbedding has been applied to the problem of penetration of gamma rays through slabs. The accuracy of the method was examined by comparison with other reliable calculations and proved to be competitive with other well-developed methods. The method has the advantages that it is much more efficient than the Monte Carlo method and that it is readily applicable to the multilayer problems. An extensive series of calculations on the transmission of gamma rays through homogeneous slabs was carried out. The energy and angular distributions of transmitted photons from monoenergetic and oblique sources were obtained for slab thickness up to 15 mean-free-paths and for 7 materials. The results of calculations were compared with experiments and found to be in good agreement. (auth)

24373 GAMMA RADIATION FLUXES NEAR A GROUND-AIR INTERFACE USING AN IMAGE SOURCE TECHNIQUE. Eisenhauer, C. (National Bureau of Standards, Washington, D. C.). Nucl. Sci. Eng., 32: 166-77(1968).

Calculations are made of the radiation flux of gamma rays that have originated from a point isotropic source and have been singly scattered in the air lying beyond a plane interface. Calculations are made in the limit that the source-detector separation distance is small compared to a mean-free-path in air. These results are interpreted in terms of an image source. The results, combined with earlier calculations of the radiation flux reflected from a condensed medium, such as ground, predict the effect of the ground-air interface on radiation fluxes in air near the interface. The results are extrapolated to source-detector separation of the order of a mean-free-path by using infinite-medium buildup factors. Comparisons with experiment show that the model produces results that are in qualitative agreement with experiment. (auth)

24374 MONTE CARLO STUDY OF DIRECTIONAL RESPONSE FUNCTIONS FOR FALLOUT RADIATION SHIELDING CALCULATIONS. Price, J. H.; French, R. L. (Radiation Research Associates, Inc., Fort Worth, Tex.). 15p. (RRA-M-73; CONF-670602-27). DTIE.

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif.

Directional response functions of the type used in reduction factor calculations employing the engineering method outlined in NBS-76 were calculated from Monte Carlo data. Response functions were determined for both "thin" and "thick" barriers and for radiation reaching the receiver from both above and below the plane of the detector. The data used in the calculations were obtained using the COHORT Monte Carlo procedure. The functions for "thin" barriers indicate slight differences in magnitude from the directional response functions based on moments method data. The response function for "thick" barriers was divided into two separate functions; one for radiation entering above and one for radiation entering below the detector plane. These two functions differed in both shape and magnitude from the single function given in NBS-76 and lead, in the cases examined, to large changes in the reduction factor. However, it is not presently clear that use of the "improved" directional response functions leads to any overall improvement in the engineering method. (auth)

Solid-State Physics

Refer also to abstracts 23361, 23374, 23382, 23593, 23707, 23804, 23805, 24205, 24235, 24786, 24789, 24804-24807, 24809, 24810, and 24812-24818.

24375 (BLG-424) THE RECOVERY OF STRUCTURAL DEFECTS IN REFRACTORY BCC METALS AFTER IRRADIATION AND AFTER COLD WORK. A Literature Survey. Nihoul, J.; Stals, L. (Centre d'Etude de l'Energie Nucleaire, Mol (Belgium)). Aug. 1967. 18p. (CONF-670718-2). Dep.

From NATO Conference on High Temperature Materials, Sandefjord, Norway.

A review is given of the recovery of structural defects in the body-centered-cubic metals tungsten, molybdenum, tantalum, and niobium. Special attention is paid to the recovery stages as found by means of electrical resistivity measurements following fast-particle irradiation and following plastic deformation. (auth)

24376 (CEA-Bib-100) DETERMINATION EXPERIMENTALE DE LA DUREE DE VIE DES PHONONS DANS LES CRISTAUX. (Experimental Determination of Phonon Lifetime in Crystals). Drifford, Maurice (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Dec. 1967. 16p. (In French). Dep.

Thesis.

The lifetime of phonons is determined by inelastic scattering of neutrons and photons (Raman scattering; optic phonon; Brillouin scattering; and acoustic phonon). Some fundamental notions on dispersion curves and anharmonic effects in crystal are reported and the results obtained on some solids are commented on. (auth)

24377 (CEA-R-3356) ETUDE CRISTALLOGRAPHIQUE ET SPECTROSCOPIQUE DES SITES CRISTALLINS DANS LA STRUCTURE "SPINELLE". (A Crystallographic and Spectroscopic Study of Crystal Sites in the "Spinel" Structure). Drifford, Maurice (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). 1967. 149p. (In French). Dep.

Thesis. Submitted to Univ. of Paris, France.

A crystallographic study on magnesium aluminates led to the determination of crystal site average distortion. A spectroscopic study of transition-element-doped spinels gave the position of the doping element in tetrahedral (A) or octahedral (B) sites, and the local distortion of the latter. The comparison of average and local parameters points to differences in the behavior of doping elements and shows the size of (A) sites are independent of the host-crystal composition while the average size of (B) sites varies with the composition. (auth)

24378 (CONF-670502–, pp 10-17) MAGNETISM OF SOME RARE EARTH ELEMENTS AND IONIC COMPOUNDS UNDER PRESSURE. Pauthenet, R.; Bloch, D.; Chaisse, F. (Grenoble Univ. (France). Laboratoire d'Electrostatique et de Physique du Metal).

Experiment results and discussion of the effect of pressure on magnetic ordering points and on the saturation magnetization of several polycrystalline rare earth elements and rare earth iron garnets are presented. (auth)

24379 (CONF-670502–, pp 18-28) PROPERTIES OF THE RARE-EARTH METALS AND ALLOYS AT HIGH PRESSURES. McWhan, D. B. (Bell Telephone Labs., Murray Hill, N. J.).

A review of recent measurements of the pressure dependence up to 85 kbar of the Néel and Curie temperatures, and crystal structures is given. The materials studied include: the elements Eu, Gd, Tb, Dy, and Ho; the Tb–Y alloy system; and a series of alloys with equal average DeGennes function. The initial slopes (dT/dP) are approximately proportional to the average DeGennes function. A polymorphic transition from a hexagonal-close-packed structure to a Sm-type structure was found with increasing pressure in many of these alloys. The Sm-type phase did not exhibit ferromagnetism but has two ordering temperatures. The higher ordering temperature of the Sm-type phase was 10% lower than that of the hcp phase, and the two ordering temperatures in the Sm-type phase differed by 17%. (auth)

24380 (CONF-670502–, pp 36-47) MAGNETIC AND CRYSTALLOGRAPHIC CHARACTERISTICS OF PRASEODYMIUM HYDRIDES. Mader, K. H.; Wallace, W. E. (Pittsburgh Univ., Pa. Dept. of Chemistry). (NYO–3454-10).

Susceptibilities (χ) and lattice parameters are reported for a series of praseodymium hydrides represented by the formula PrH_x in which x varies from 0.99 to 2.57. χ was measured from 4 to 300°K and at field strengths up to 21 kOe. The samples are two phase for $x < 1.85$. Curie–Weiss behavior was observed for all samples above 100°K with slopes in fairly good agreement with that expected for an assemblage of free tripositive ions. Deviations occurred below 100°K. These are two kinds—negative for $x < 2.1$ and positive for $x > 2.1$. The deviations in the first case are small and are thought to result from the crystal field interaction. The positive deviations are ascribed to a change of valence for Pr from 3+ to 4+. Magnetic, electric, and crystallographic evidence is in accord with this postulate. There is no indication of magnetic ordering in the Pr hydrides at 4.2°K. This is attributed to weakness of the interactions and to the valence changes that reduce the atomic moment. (auth)

24381 (CONF-670502–, pp 48-57) MAGNETIC BEHAVIOR OF RARE EARTH COMPOUNDS WITH SINGLET CRYSTAL FIELD GROUND STATE. Cooper, Bernard R. (General Electric Co., Schenectady, N. Y. Research and Development Center).

The susceptibility and high field magnetization expected for rare earth compounds with singlet crystal field ground state are discussed. In particular, the limitations of molecular field theory in treating exchange effects on the susceptibility, nonlinear magnetization, and criterion for magnetic ordering in such systems are considered. (auth)

24382 (CONF-670502–, pp 58-67) MICROWAVE ABSORPTION IN DYSPROSIUM SINGLE CRYSTALS. Blackstead, H. A.; Donoho, P. L. (Rice Univ., Houston, Tex.).

Microwave power absorption was observed at a frequency of 9.8 GHz in single-crystal c-plane platelets of dysprosium at temperatures from 40 to 179°K. The rf magnetic field was aligned parallel to an a-axis (easy axis), and the dc magnetic field was aligned along a b-axis (hard axis), either perpendicular to the rf field or at an angle of thirty degrees to it. At temperatures below 85°K, and for temperatures from 85°K to approximately 110°K with $H_{dc} > H_c$, a strong resonance line with a width of approximately 1 kOe was observed. This resonance, predicted from spin-wave analysis, is apparently related to the strong six-fold basal-plane anisotropy, which is important below 110°K. With the dc field perpendicular to the rf field, and for temperatures above 110°K, there was no apparent field-dependence of the absorption for $H_{dc} < h_c$. At higher fields, however, the absorption increased rapidly, reaching a maximum at H_f, the field at which the fan structure collapsed to ferromagnetic alignment. With further increase of the field, the absorption then decreased linearly. No absorption was observed above 179°K, the temperature for the transition from the helicoidal spin structure to the paramagnetic state. Frequency-dependence studies are in progress in the range 8 to 25 GHz. (auth)

24383 (CONF-670502–, pp 68-77) NUCLEAR MAGNETIC RESONANCE MEASUREMENTS IN THE NaCl-TYPE RARE-EARTH GROUP VA INTERMETALLIC COMPOUNDS. Jones, E. D. (Sandia Corp., Albuquerque, N. Mex.).

Phosphorus nuclear magnetic resonance (NMR) was observed in the paramagnetic state of NaCl-type rare earth intermetallic compounds REP (RE = rare earth). The phosphorus Knight shifts were measured in the temperature range from 100 to 600°K. Analyzing the temperature-dependent Knight shifts in terms of a uniform-conduction electron spin polarization model yields values for the s–f exchange energy Γ. The arsenic, antimony, and bismuth Knight shift data in SmAs, SmSb, and SmBi are also presented. For the Sm^{3+} compounds, theoretical predictions concerning the behavior of the temperature dependence of the Sm^{3+} $\langle S(T) \rangle$ are verified. (auth)

24384 (CONF-670502–, pp 78-88) EPR ANGULAR SPECTRA OF GADOLINIUM IN RARE-EARTH DOUBLE NITRATE SINGLE CRYSTALS. Buckmaster, H. A.; Dering, J. C.; Fry, D. J. I. (Calgary Univ. (Alberta). Dept. of Physics).

A systematic study of the 10-GHz electron paramagnetic resonance (EPR) spectra of the gadolinium ion (Gd^{3+}; ^8S) in isomorphic, diamagnetic lattices of hydrated, rare earth double nitrate single crystals is reported. These lattices are of the form M_2^{III} M_3^{II} $(NO_3)_{12} \cdot 24\ H_2O$ where M^{III} is bismuth or lanthanum and M^{II} is zinc or magnesium. The ratio of Gd^{3+} to M^{III} ions was ≈0.1%. The experimental data for temperatures of 290 and 77°K are fitted to the phenomenological spin-Hamiltonian for C_{3i} symmetry. The angular dependence of the spectra showed substantial variations from that predicted, which were not reported previously. These variations were not inconsistent with C_{3i} symmetry but cannot be completely described by any spin-Hamiltonian of the above form. This raises doubts as to the usefulness of the spin-Hamiltonian formalism because the intrinsic symmetry of the terms is too high to describe the variations. (auth)

24385 (CONF-670502–, pp 89-100) TEMPERATURE VARIATION OF Gd ESR SPECTRA IN CUBIC AND AXIAL CRYSTALS. Abraham, M. M.; Boatner, L. A.; Lee, E. J.; Weeks, R. A. (Oak Ridge National Lab., Tenn.).

The electron spin resonance of gadolinium was observed and the temperature variation of the splitting was studied in single crystals of CeO_2, ThO_2, CaF_2, and CaO, where the symmetry of the local crystalline field was cubic. Similar measurements were made on single crystals of $La(C_2H_5SO_4)_3 \cdot 9H_2O$, $LaCl_3$, and $LaBr_3$ in which the symmetry of the local field was axial. Absolute signs of "spin" Hamiltonian parameters were determined from the relative intensity of the resonance lines at low temperature. (auth)

24386 (CONF-670502–, pp 112-31) NON-STOICHIOMETRY AND CRYSTAL DEFECTS IN THE SOLID STATE CHEMISTRY OF THE LANTHANIDES. Anderson, J. S. (Oxford Univ. (England)).

Three classes of lanthanide compounds, all largely ionic in character, which display a wealth of nonstoichiometric phenomena, were considered. The nitrides appear to come into that group of phases with such a high defect concentration that a completely random model is hardly acceptable. In the oxides and chalcogenides there are indications of strong tendencies to the maintenance of strict local ordering. All these compounds are therefore of particular interest in the present stage of defect theory, for which the central problem is to see how the one viewpoint, existence of regions of perfect local order in some coherent structural relationship to each other, can be fully harmonized with the experimental thermodynamics and the statistical thermodynamics of solids. (auth)

24387 (CONF-670502–, pp 132-44) POINT DEFECTS IN SOME RARE EARTH DIHYDRIDES. Libowitz, G. G.; Lightstone, J. B. (Kennecott Copper Corp., Lexington, Mass. Ledgemont Lab.).

The rare earth dihydrides exhibit large positive and negative deviations from stoichiometry. By comparing experimental data for lanthanum, cerium, and gadolinium dihydrides with previously derived thermodynamic expressions relating chemical activities with deviations from stoichiometry, the defects responsible for the nonstoichiometry in these compounds may be identified. It is shown that the predominant defects in the stoichiometric rare earth dihydrides are Frenkel defects, with excess hydrogen interstitials causing positive deviations from stoichiometry and excess hydrogen vacancies causing negative deviations from stoichiometry. The derived equations also permitted calculation of

the intrinsic Frenkel defect concentrations and energies and entropies of defect formation. Intrinsic defect concentrations ranged from 2 to 5% over the temperature range from 300 to 800°C. The vibrational entropy change for Frenkel defect formation was found to be negative and to contribute at least as much to the free energy of defect formation as does the enthalpy term. (auth)

24388 (CONF-670502–, pp 145-54) THE CRYSTAL CHEMISTRY OF SELECTED AB_2 RARE EARTH COMPOUNDS WITH Se, Te, AND Sb. Wang, R.; Steinfink, H. (Texas Univ., Austin).

Crystal structures were determined for REB_2 compounds where RE is a rare earth and B an element of groups V and VI. Data are presented in tables and diagrams. (M.C.G.)

24389 (CONF-670502–, pp 166-74) MAGNETIC PROPERTIES OF DYSPROSIUM. Jordan, R. G. (Sheffield Univ. (England)).

The magnetic properties of several single crystals of dysprosium were investigated along the principal directions of the hcp structure over the temperature range from 4 to 300°K, and in applied magnetic fields up to 18 Koe. The measurements in the basal plane agreed in general with the previous work. Along the c direction, a small spontaneous moment was observed, appearing at 125 ± 2, 89 ± 3, and 88 ± 4°K for the three crystals studied. The corresponding spontaneous moments at 0°K are 1.9 ± 0.4, 2.7 ± 0.3, and 2.6 ± 0.3 emu./gm. An analysis of the results would seem to indicate that the transition from antiferromagnetism to ferromagnetism is controlled by the strong dependence of the indirect exchange interaction with lattice dimensions. On the basis of this analysis the ferromagnetic c axis lattice parameter was calculated for $90°K \leq T \leq 179°K$. (auth)

24390 (CONF-670502–, pp 225-7) CRYSTAL STRUCTURES OF SULFIDES Yb_3S_4 AND MnY_2S_4. Chevalier, R.; Laruelle, P.; Flahaut, J. (Paris Univ. (France)).

Crystallographic studies were made of the structure of Yb_3S_4 and MnY_2S_4. The Yb_3S_4 is orthorhombic with a cell of dimensions: a = 12.71, b = 3.81, and c = 12.88 Å and belongs to space group PnMa. MnY_2S_4, orthorhombic too, shows a cell of similar dimensions: a = 3.78, b = 12.64, and c = 12.74 Å but the systematic extinctions are characteristic of the space group cmcm. (M.C.G.)

24391 (CONF-670502–, pp 228-38) RARE EARTH CHEMISTRY OF LASERS. Yocom, P. N. (Radio Corp. of America, Princeton, N. J. RCA Labs.).

It is shown that the important quantities for obtaining laser action are the frequency of the transition, the fluorescent linewidth, the dipole moment matrix element of the transition, and the cavity properties, and how these quantities are interrelated. It is then pointed out how both di- and trivalent lanthanide ions can provide the needed properties under suitable conditions. The subject of crystal lasers is presented on the basis of the charge on the ion replaced by the lanthanide ion. The properties and preparation of divalent lanthanide ions are presented as well as the charge compensation of the trivalent ions in divalent sites. Sensitization in crystalline hosts is described and a short, qualitative discussion of line broadening presented. The glasses containing lanthanide ions that show laser action are described and the effects that a glass matrix have on the properties of the lanthanide ions discussed. Short descriptions of the rare earth chelate systems that show laser action are given, along with mention of the inorganic, nonaqueous, liquid laser system. (auth)

24392 (CONF-670502–, pp 295) MAGNETIC PROPERTIES AND MAGNETIC STRUCTURES OF THE TCo_3 INTERMETALLIC COMPOUNDS, WHERE T IS A RARE EARTH METAL OR YTTRIUM. Lemaire, R.; Pauthenet, R.; Schweizer, J.; Silvera, I. (Grenoble Univ. (France). Laboratoire d'Electrostatique et de Physique du Metal. Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires).

The magnetization of the rare earth–cobalt compounds TCo_3 was measured at fixed temperatures between 2 and 1000°K in magnetic fields that varied up to 29,000 Oe. The Curie temperatures lie in the range from 300 to 612°K; they increase rapidly with the value of the spin moment of the associated rare earth. (M.C.G.)

24393 (CONF-670502–, pp 307-9) MAGNON DISPERSION RELATION IN RARE EARTH METALS FROM INELASTIC NEUTRON SCATTERING. Moeller, H. Bjerrum (Danish Atomic Energy Commission, Risoe. Research Establishment); Houmann, J. C. Gylden; Mackintosh, A. R. (Tekniske Hoejskole, Copenhagen (Denmark)).

The magnon dispersion relations in Tb and a Tb–10% Ho alloy were studied by inelastic neutron scattering. In pure Tb tendency toward spiral ordering was observed. When 10% Ho was added, this tendency was considerably enhanced and the spiral structure was stable over a greater temperature range. In the alloy a strong coupling between magnons and transverse phonons propagating in the c-direction, which leads to mixed excitations and a splitting apart of the dispersion curves, was observed. (M.C.G.)

24394 (CONF-670502–, pp 471-81) EFFECT OF THE s–f EXCHANGE IN DILUTE ALLOYS. Yosida, Kei (Tokyo Univ. (Japan). Inst. for Solid State Physics).

It is well established that the s–f exchange interaction between the conduction electrons and the localized spin of 4f electrons plays a decisive role in the magnetic and electrical properties of rare earth metals and alloys. The s–f exchange interaction has an effect particularly in dilute alloys of rare earth in nonmagnetic metals. Since Kondo succeeded in explaining the resistivity minimum in dilute alloys of Mn and Fe in noble metals the effect of the s–f or s–d exchange on the electrical resistivity of dilute alloys was investigated in detail by Suhl, Arbikosov, Nagaoka, and many others. These investigations are reviewed in connection with dilute alloys of rare earths and recent experiments on this anomalous effect are also briefly mentioned. (auth)

24395 (CONF-670502–, pp 482-6) BAND STRUCTURE, FERMI SURFACE, AND PHYSICAL PROPERTIES OF THE RARE-EARTH METALS. Freeman, A. J. (Massachusetts Inst. of Tech., Cambridge. National Magnet Lab.).

A review is given of the present understanding of some of the electric, magnetic, and optical properties of rare earth metals based on recent ab initio energy band calculations. (auth)

24396 (CONF-670502–, pp 506-9) TEMPERATURE DEPENDENCE OF THE HYPERFINE FIELD IN RARE EARTH–GOLD COMPOUNDS. Dunlap, B. D.; Dwight, A. E.; Kalvius, G. M.; Kimball, C. W. (Argonne National Lab., Ill.).

Ordered binary alloys of gold with various rare earths (Yb, Tm, Er, and Ho) were investigated by observing the Mössbauer hyperfine fields in ^{166}Er, ^{169}Tm, ^{171}Yb, and ^{197}Au nuclei. In these compounds the Au spectra are asymmetric doublets, which are roughly independent of temperature. In some cases the rare earth Mössbauer spectra show magnetic splittings and evidence of electronic relaxation effects. (auth)

24397 (CONF-670502–, pp 510-21) MAGNETOSTRICTION IN DILUTE RARE EARTH IRON GARNETS. Clark, A. E.; Rhyne, J. J.; Callen, E. R. (Naval Ordnance Lab., White Oak, Md.).

The conventional single-ion theory of magnetoelastic coupling successfully accounted for the temperature dependence of the huge magnetostriction observed in the heavy rare earth metals. It also accounted for the temperature dependences in rare earth iron garnets. These measurements were extended to low temperatures on GdIG and on a series of partially substituted $Dy_xY_{1-x}IG$ single crystals. It is shown that: the magnetostriction is linear in Dy concentration, establishing a single-ion source, and conventional statistical theory, which ignored crystal field effects, can be preserved for some magnetostrictive modes, but must be modified for others. (auth)

24398 (CONF-670502–, pp 556-67) ON THE EXISTENCE OF AN ANTIFERROMAGNETIC PHASE IN RFe_7 COMPOUNDS. Weik, H.; Susedik, E.; Turner, M. (Cincinnati Univ., Ohio. Dept. of Physics).

Results of previous neutron-diffraction studies on peritectic compounds of Pr and Nd with Fe of the type RFe_7 suggested the existence of an antiferromagnetic phase beyond the magnetically measured Curie temperatures. In order to prove or disprove this supposition, measurements of the specific heat and electric resistivity were performed with an arc melted and homogenized Nd–Fe sample of the same composition and treatment as used in the neutron-diffraction studies. The specific heat measurements, performed between room temperature and 110°C, exhibited a relative maximum at 56°C, in agreement with the magnetically determined Curie temperature of 53°C, and show with increased sample temperature a further increase, indicating a ferromagnetic–antiferromagnetic transition. Measurements of the electric resistivity were in agreement with this and seemed to indicate a Néel temperature at about 300°C. The results support newer magnetic measurements of other RFe_7 compounds in which signs of antiferromagnetism were found. (auth)

24399 (CONF-670502–, pp 581-90) OPTICAL AND ELECTRICAL PROPERTIES OF YTTERBIUM THIN FILMS. Okorie, Ogba A. (Southern Univ., Baton Rouge, La. Dept. of Physics); Singh, Sohan (Howard Univ., Washington, D. C.).

In addition to reflectance and transmittance, the thickness and resistivity of Yb thin films deposited by vacuum evaporation were measured in the spectral region 0.5 to 6.8 microns. From these data, the refractive index, the extinction coefficient, the absorption coefficient, the carrier density, and the

types of carriers as well as their relaxation time were calculated. Drude theory applied well between 1 to 3.5 microns. Hagen–Ruben's relation also applied at intervals. The infinite wavelength index of refraction is 10.9 while the indirect transition is 1.8 eV. The mean free path of the carriers is 236 Å, the carrier velocity is 3.17×10^7 cm/sec, and the relaxation time is 7.45×10^{-14} sec. Empirically, the reflectance and the transmittance are related by an expression of the form $R = Ae^{-BT}$ Similar expression was determined for the reflectance and the wavelength. (auth)

24400 (CONF-670502–, pp 591-602) ELECTRICAL CONDUCTION AND DIELECTRIC BREAKDOWN IN THIN EVAPORATED LAYERS OF SEVERAL RARE EARTH OXIDES. Fromhold, A. T. Jr.; Foster, W. D.; Harbuck, T. A.; Mosley, R. B. (Auburn Univ., Ala.).

Some electrical measurements at 300°K are reported for thermally evaporated oxides 300 to 6000 Å in thickness of the rare earth metals La, Ce, Pr, and Nd. Thin evaporated aluminum electrodes were utilized to impress voltages in the range zero to 80 volts across the oxide layers; electric fields as large as 5×10^6 volts/cm could be reached prior to destructive dielectric breakdown. Low field ($E \lesssim 10^4$ volts/cm) current–voltage characteristics were almost linear. High field ($E \lesssim 10^5$ volts/cm) current–voltage behavior was initially quite erratic, since the layers experience many nondestructive dielectric breakdowns. After voltage cycling, the current–voltage characteristics tended to become stable, reproducible, and nonlinear, with current densities ranging from one microampere/cm^2 to one ampere/cm^2. At 10^{-6} torr the initial current–voltage characteristics were less erratic and could be stabilized by voltage cycling more readily than those measured at ambient pressure. A reversible pressure effect was observed in which the conductivity of the films increased (e.g., by a factor of 5 for neodymium oxide) as the pressure was reduced from atmospheric to 10^{-6} torr. This indicated an oxygen pressure-dependence of the stoichiometry and corresponding ionic defect concentration of the oxide. Least-squares analysis using the expressions for Schottky emission, Frenkel–Poole effect, and field-induced hopping ($I \propto \sinh \beta E$) indicated that the latter is the more likely current-transport mechanism. (auth)

24401 (CONF-670502–, pp 603-14) PERMANENT MAGNET PROPERTIES OF YCo_5 POWDERS. Strnat, K. J.; Olson, J. C.; Hoffer, G. (Air Force Materials Lab., Wright-Patterson AFB, Ohio).

Ferromagnetic intermetallic compounds of the type RCo_5 between several rare earths and cobalt were found to be promising candidates for a technological application as fine particle permanent magnets. Experiments with powders of YCo_5 prepared by mechanical milling are described. Intrinsic coercivities up to ~3000 Oe were achieved for particle sizes near 5μ, but further size reduction unexpectedly lowered H_c again. This is explained as the result of plastic deformation damage in the crystallites. Initial experiments suggest that two measures can reduce the "overmilling effect" and may allow attainment of higher coercive forces and consequently higher energy products: grinding below room temperature and high-vacuum annealing of the powders. Oxidation of the smallest particles seemed to occur during grinding unless air was excluded and this resulted in a further reduction of H_c. However, particles in an epoxy matrix and powder compacts did not change their properties appreciably during several months of aging at room temperature. Magnetization curves are presented for a 64% dense compact having an energy product of 1.2 MGOe. (auth)

24402 (CONF-670502–, pp 618-26) FREQUENCY DEPENDENCE OF MAGNETIC LOSSES IN Ho IN THE NEIGHBORHOOD OF THE CURIE TEMPERATURE. Gerstein, B. C.; Olander, F. (Ames Lab., Iowa).

The frequency dependence of imaginary and real susceptibilities of polycrystalline Ho was measured in the neighborhood of the ferromagnetic ordering temperature. The nature of the $\chi'-\omega-T$ and $\chi''-\omega-T$ surfaces was defined in the range $10 \leq T \leq 25$°K $22 \leq \omega \leq 110$ Hz. For the sample measured, the resonant frequency for domain wall motion lay below 22Hz indicating that ac susceptibilities of Ho measured above 10 Hz will not agree with dc measurements. The results were fitted to a driven oscillator model and were found to correlate more closely with a model in which effective mass is ignored than with one in which it is not, but the agreement was not completely satisfactory. (auth)

24403 (CONF-670502–, pp 627-34) ELECTRICAL RESISTIVITY AND SEEBECK EFFECT OF THULIUM SINGLE CRYSTALS. Legvold, Sam; Edwards, L. Roger (Iowa State Univ. of Science and Technology, Ames).

Single crystals of Tm were grown by the strain anneal technique. The electric resistivity and the Seebeck coefficients were measured along the three crystallographic directions $\langle 11\bar{2}0\rangle$, $\langle 10\bar{1}0\rangle$, and $\langle 0001\rangle$ as a function of temperature from 4 to 300°K. The electric resistivity results indicate a Néel temperature of 57.5°K with no evidence for other magnetic transitions. The Seebeck coefficients also indicated a Néel temperature of 57.5°K. However, the Seebeck coefficient of the $\langle 0001\rangle$ crystal showed a second transition at 32°K, which is in good agreement with low field magnetic susceptibility measurements on polycrystalline Tm. Neutron diffraction data of Koehler et al., indicated the transition to be about 38°K. Both measurements exhibited a significant anisotropy between the $\langle 0001\rangle$ direction and the basal plane. (auth)

24404 (CONF-670502–, pp 635-52) STRUCTURE ELECTRONIQUE DES MONOCARBURES DE TERRES RARES. (Electronic Structure of Rare-Earth Monocarbides). Lallement, R. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). (In French).

Studies were made of the electric conductivity, thermoelectric behavior, and magnetic susceptibility of the rare earth carbides. By analysis of the results of these studies, the electronic structure of the carbides could be determined. (M.C.G.)

24405 (COO–1255-5) RADIATION DAMAGE TO SILICA STRUCTURES. Technical Progress Report. Bale, Harold D. (North Dakota Univ., Grand Forks. Dept. of Physics). Mar. 4, 1968. Contract AT(11-1)-1255. 11p. Dep. CFSTI.

A step scanning device and a Mo rotating anode for use in the small-angle x-ray study of radiation damage to silica glass are described briefly. Scattering studies of glass samples suggest that damage resulting from neutron irradiation is similar but not identical to effects of quenching. Radial distribution curves for compacted and noncompacted silica powder samples show a shift of the Si–Si distance from 3.1 to 2.9 Å after compaction. (A.G.W.)

24406 (GA–6862) PHONON SPECTRUM OF BERYLLIUM OXIDE. Young, James A.; Koppel, J. U. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). Apr. 29, 1966. Contract AT(04-3)-167. 15p. Dep. CFSTI.

A simple model for the lattice dynamics of BeO is described. The phonon spectrum computed from this model is presented. The results are expected to be useful in computing neutron scattering cross sections. (A.G.W.)

24407 (GAMD–8026) DESCRIPTION OF PROGRAM DFCTAV AND THE DEFECT MODEL WHICH IT IS DESIGNED TO SOLVE. Colwell, J. F. (Gulf General Atomic, Inc., San Diego, Calif.). June 7, 1967. Contract AT(04-3)-167. 15p. Dep. CFSTI.

A model for defects in irradiated graphite based on equations of Woolley [Brit. J. Appl. Phys., 14: 778(1963)] modified to include vacancy lines is presented. A method for integration of these equations and a FORTRAN computer program are described. (A.G.W.)

24408 (IA–1128, pp 21-54) SOLID STATE PHYSICS AND METALLURGY. (Israel Atomic Energy Commission, Tel Aviv).

Developments are reported for studies on: ferroelectric phase transitions by ir absorption; anisotropy and phase transition effects in neutron scattering by KH_2PO_4; anomalous behavior of dielectric constant of KH_2PO_4 at high temperatures; spontaneous polarization of KH_2PO_4 and KD_2PO_4; Moessbauer effect in double minimum potentials and dynamics of Kr in hydroquinone clathrates; ESR spectrum of Co^+ produced by gamma irradiation in single crystals of CaO; Moessbauer effect in SnI_4 and in tetraiodides of Ge, Si, and C; Moessbauer spectroscopy of covalent inorganic iodine compounds; Moessbauer effect in solid Kr and ^{83}Kr produced by beta decay of ^{83}Br; preparation of ^{83}Br compounds and carrier-free ^{83m}Kr; Moessbauer effect in Kr hydrates; ^{129}I internal fields in insulating ferromagnet CrI_3; Moessbauer effect of ^{57}Fe impurities in LiOH-type layered crystals; Moessbauer studies on ferrite materials and vanadium hydrides; hydrogen embrittlement of Ti; sample mounting facility for NMR measurements; neutron powder diffraction of Cr_2O_3 and dicalcium ferrite; magnetic mirror polarized neutron facility; neutron spectrometer; facility for neutron scattering experiment; nucleating and growth of martensite in U–Cr alloys; decomposition of gamma phase in U–Mo alloys; effects of elements on activity of U in liquid Ag; luminescence and thermally stimulated currents in insulating and semiconducting diamonds; rate equations for luminescent processes; optical lattice vibrations in finite ionic crystals; anharmonic mode-mixing in ionic ferroelectrics; vibronic effect in temperature dependence of soft frequency of $BaTiO_3$; dynamics of accidental degeneracies; covalency effects in trigonal distortion; and high-order coupling terms in the Jahn–Teller effect. (P.C.H.)

24409 (JINR–P4-3746) O RASCHETE KONSTANT SVYAZI ATOMOV PRIMESEI V METALLAX. (On the Calculation of the

Coupling Constants of the Atoms in Metals Admixtures). Priezzhev, V. B. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1968. 16p. (In Russian). Dep.

Strength constants in the Cu lattice with the Be admixtures are investigated. Changes of the strength constants in the zero and first coordination sphere are determined. An explicit separation of the contributions to the strength constants of short- and long-range forces is made and their changes are measured when introducing the admixtures. (auth)

24410 (JINR-P14-3776) ISSLEDOVANIE SOSTOYANIYA IONOV ZHELEZA V AgCl, DOPIROVANNOM ^{57}Fe, S POMOSHCH'YU EFFEKTA MESSBAUERA. (Study of Iron Ions in ^{57}Fe-Doped AgCl Using the Moessbauer Effect). Hennig, K. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Neutron Physics). 1968. 5p. (In Russian). Dep.

The Mössbauer effect in AgCl doped with ^{57}Fe confirms one of the interpretations of the velocity spectrum obtained earlier in AgCl doped with ^{57}Co, according to which the divalent substitutionally placed iron is associated with a cation vacancy. (auth)

24411 (LA-DC-8636) TRANSIENT RADIATION EFFECTS IN OPTICAL MATERIALS. Mace, Phillip N.; Gill, Dennis H. (Los Alamos Scientific Lab., N. Mex.). [nd]. Contract W-7405-eng-36. 20p. Dep. CFSTI.

The use of the prototype Phermex electron accelerator to simulate high-dose-rate nuclear-radiation environments is discussed. The free electron density produced in optical materials by the beam from this machine, and that expected from a typical incident prompt-gamma radiation flux are compared. An experimental setup to measure the effects on the transmission of selected optical materials is described, and data obtained on these materials are presented. Transient or permanent loss of transmission was observed in optical glasses and GE-101 fused quartz, but no effect was seen in purified fused silica. Reflectivity of front-surface aluminum and dielectric mirrors was also checked and no effects were seen. (auth)

24412 (UCRL-18119) ELECTRON RESONANCE STUDIES OF CRITICAL FLUCTUATIONS IN ANTIFERROMAGNETS. Siebert, Jerome F. (California Univ., Berkeley. Lawrence Radiation Lab.). Mar. 1968. Contract W-7405-eng-48. 82p. Dep. CFSTI.

Thesis.

Magnetic relaxation in the three antiferromagnets $CsMnF_3$, $RbMnF_3$, and $KMnF_3$ has been studied as a function of temperature, with special emphasis on the critical region just above T_N. $CsMnF_3$ ($T_N \approx 53°K$) has a large dipolar anisotropy which makes the basal plane an easy plane, so that the position of the low-frequency mode depends only on the magnitude of the applied field. It was therefore possible to make a detailed, continuous study of the AFR-EPR transition in this crystal without using the high-field or high-frequency techniques ordinarily required to observing AFR in anisotropic antiferromagnets. A large broadening of the line width was observed immediately above T_N, as predicted by the conventional theory of critical fluctuations. However, the broadening was asymmetric, suggesting that the intrinsic spin relaxation is masked by inhomogeneous broadening and sample-dependent effects. An anomalous line width "hump" in the AFR region can also be attributed to such effects. Since the external field partially polarizes the sample, the presence of anisotropy produces a shift in the resonance field, even in the paramagnetic region. The resonance fields in $CsMnF_3$ were measured as a function of temperature between 75 and 300°K with the field applied parallel and perpendicular to the c axis. The results were qualitatively consistent with the behavior and temperature dependence of the anisotropy field predicted by theory and determined from low-temperature torsion experiments. However, quantitative agreement could be obtained, especially at the lower temperatures. $RbMnF_3$ ($T_N \approx 82.5°K$) and $KMnF_3$ ($T_N \approx 88°K$) are low-anisotropy, cubic antiferromagnets, so that intrinsic spin processes should dominate the relaxation. In both crystals the linewidth remained constant as the temperature was lowered from room temperature through T_N. This result is inconsistent with existing theories of spin relaxation based on the conventional theory of critical fluctuations. Therefore, a critical review of these theories was made and some possible modifications are proposed that will produce better agreement between theory and experiment. For instance, conventional theories do not consider the effect on spin relaxation of collective oscillations above T_N, i.e., "para-magnons," whose existence has recently been established experimentally in $RbMnF_3$. For completeness, this modified theory of spin relaxation is extended to the case of anisotropic antiferromagnets and compared with experiment. (auth)

24413 (WANL-TME-1666) DETS: A COMPUTER PROGRAM FOR CALCULATING THE EFFECTIVE TEMPERATURE FOR A CRYSTALLINE SOLID. Sowden, Marilyn M.; Johnston, A. S. (Westinghouse Electric Corp., Pittsburgh, Pa. Astronuclear Lab.). Sept. 7, 1967. Subcontract NP-1. 73p. Dep. CFSTI.

DETS is a program which calculates the values of the specific heat, the Debye-Waller factor, the average energy per mode, the DEBYE temperature for each of these three cases, and the effective temperature. It was written for the CDC-6600 computer in FORTRAN IV. The specific heat, Debye-Waller factor, and average energy per mode are calculated from the normal mode frequency distribution of a crystal lattice. The three corresponding Debye temperatures are obtained by iteration on the upper limit of the integrals from the corresponding Debye model formulas. The effective temperature is obtained from the Debye model using a Debye temperature. (auth)

24414 (AD-663345) CERTAIN CHARACTERISTICS OF RADIATIVE CENTERS IN SYNTHETIC GERMANIUM-DOPED QUARTZ. Vakhidov, Sh.; Ikramov, G.; Kaipov, B. Translated from Izv. Akad. Nauk Uzb. SSR, Ser. Fiz.-Mat. Nauk, 10: No. 4, 50-2(1966). 8p. (FTD-HT-67-426). CFSTI.

Electron paramagnetic resonance (EPR) was used in an investigation of the radiative defects in crystalline quartz activated with impurities of germanium, aluminum, and some alkali metals. Specimens 1 × 4 × 10 mm were irradiated from a ^{60}Co γ source at 380 r/sec. The irradiation temperature was varied from the boiling point of liquid nitrogen and up. During the measurement of the EPR spectrum the principal optical axis of the specimen was placed parallel to the direction of the magnetic field. It is shown that at any irradiation dose, the EPR lines pertaining to Ge and Al impurities appear independently on the spectrum. Several tens of millions of roentgens are required to saturate the Griffiths-Owen-Ward (GOW) centers; smaller doses, of the order of several millions of roentgens, are required to saturate the 1 and 2 centers. The GOW and 1 and 2 centers are shown to appear as the result of irradiation and disappear, independently of each other, as the result of thermal or optical annealing. Investigation of the absorption spectra showed also that GOW and 1 and 2 centers exist independently from each other, have different probabilities of formation under the effect of ionizing radiation, and can be annealed independently when heated or illuminated. (auth)

24415 (AD-665707) THEORY OF CERTAIN PHENOMENA IN A PARAMAGNETIC SUBSTANCE THAT ARE DEPENDENT ON THE SPIN-PHONON INTERACTION. Kochelaev, B. I. Translated from pp 78-97 of Paramagn. Rezonans, Nauch. Sov. Magn. Akad. Nauk SSSR, Kazan. Gos. Univ. Kazansk. Filial Akad. Nauk SSSR, Dokl. Soveshch., 1964. 33p. (FTD-HT-66-567). CFSTI.

A theoretical explanation is given for the following paramagnetic phenomena caused by the spin-phonon interaction: (1) absorption of the energy of an alternating magnetic field parallel to a constant field; (2) absorption of acoustic energy in a paramagnetic substance due to the interaction of spins with each other and with thermal phonon; (3) rotation in the plane of polarization of a cross-polarized acoustic wave during passage through a paramagnetic crystal; (4) interaction of spins through the phonon field; and (5) electron paramagnetic resonance saturation. The theory is developed in a number of works by the author. New results are given on the last phenomenon listed. (auth)

24416 QUADRUPOLE SPLITTINGS AND PARAMAGNETIC SHIFTS IN THE NMR OF ^{27}Al IN RARE EARTH ALUMINUM GARNETS. Edmonds, D. T.; Lindop, A. J. (Clarendon Lab., Oxford). J. Appl. Phys., 39: 1008-9(Feb. 1, 1968).

The nuclear magnetic resonance of ^{27}Al at both the a and d aluminum sites of dysprosium aluminum garnet (DAG), terbium aluminum garnet (TbAG), and ytterbium aluminum garnet (YbAG) have been measured at several temperatures between 4 and 290°K. The quadrupole coupling constants $e^2qQ/\hbar$ in MHz for the d and the a sites were temperature independent and equal to 5.731 and 0.320 in TbAG, 5.873 and 0.447 in DAG, and 6.300 and 1.053 in YbAG. The increase of the effective internal magnetic field at an aluminum nucleus expressed as a percentage of the externally applied field (the paramagnetic shift) which reaches values of 2% at 4.2°K for YbAG was calculated for YbAG assuming only magnetic dipole interaction and shown to be in excellent agreement with experiment at temperatures between 4.2 and 290°K. For DAG and TbAG in which the paramagnetic shift reaches 4.8% at 100°K and 6.2% at 77°K, respectively, a similar calculation must await more accurate wave functions for the excited states of the magnetic ions. (auth)

24417 TEMPERATURE DEPENDENCE OF THE ELECTRIC PROPERTIES OF TUNGSTEN DISULFIDE IRRADIATED IN A NUCLEAR REACTOR. Spitsyn, I.; Pikaeva, V. I.; Mikhailenko, I. E. (Inst. of Physical Chemistry, Moscow). Dokl. Akad. Nauk SSSR, 177: 1390-3(Dec. 21, 1967). (In Russian).

Radiation effects on electrical properties of tungsten disulfide, $WS_{2.3}$, irradiated in a reactor by a slow neutron flux 1.2×10^{10}

n/cm^2 sec with intensity of 10^4 r/sec, were studied. Identification of radioactive isotopes, carried out in a 256-channel amplitude analyzer showed the γ and β spectra of tungsten isotopes $^{187}W(E_{\gamma max} = 0.78$ MeV and $E_{\beta max} = 1.33$ MeV, $T_{\frac{1}{2}} = 24.1$ hr) and $^{185}W(E_{\beta max} = 0.43$ MeV, $T_{\frac{1}{2}} = 73.2$ days). The sulfur component was also activated. The β spectrum obtained after ^{187}W decay was the sum of $^{185}W + {}^{35}S$ with the ^{35}S activity ($E_{\beta max} = 0.167$ MeV, $T_{\frac{1}{2}} =$ 87.1 days) equal to ~6% of the activity of ^{185}W. Data obtained indicated that radioactive emission induced significant changes in electrical properties of the tungsten disulfide. (R.V.J.)

24418 EFFECT OF HYDROSTATIC PRESSURE ON THE Mn, As, AND Sb NMR IN FERROMAGNETIC MnAs AND MnSb. Schirber, J. E.; Anderson, D. H. (Sandia Lab., Albuquerque, N. Mex.). J. Appl. Phys., 39: 1010-11(Feb. 1, 1968).

The effect of hydrostatic pressure to about 4 kbar on the Mn, As, and Sb zero-field NMR frequencies in the ferromagnetic compounds MnAs and MnSb has been determined in powder samples from 4°K to about room temperature. Low-temperature data are required because these pressure derivatives are quite temperature dependent and decrease in a nonlinear fashion with decreasing temperature. The derivatives tend to constant values for $T/T_C \leq 0.3$ of d ln $\nu^{55}/dP = -5.2$ (±0.2), d ln $\nu^{75}/dP = -9.3$ (±0.3) in MnAs and d ln $\nu^{55}/dP = -3.5$ (±0.1), d ln $\nu^{123}/dP = -10.9$ (±0.3) in MnSb (all in units of 10^{-3} $kbar^{-1}$). (auth)

24419 THERMAL ANNEALING OF RADIATION DAMAGE IN SOLAR CELLS. Fang, P. H. (Goddard Space Flight Center, Greenbelt, Md.). Astronaut. Acta, 13: 147-54(Mar.-Apr. 1967).

Silicon solar cells, used extensively as a source of space power supply, have proven to be very reliable except for the degradation of power output due to the charged-particle space radiation. By thermal annealing of the cells, typically, for 15 min at 400°C, complete recovery of the power output, which had been degraded by electron irradiation, was demonstrated. Annealing and irradiation were repeated many times with equally successful results. Damage due to electron irradiation could always be annealed independently of electron energy up to 55 MeV and presumably could be done up to several hundred MeV. At very high energies, a spallation process might occur, which would produce large clusters of defects difficult to anneal. However, in the space radiation environment, the concentrations of electrons of this very high energy is not significant. For more populous low-energy electrons, no upper limit to the total flux was foreseen, provided that intermediate annealing is carried out before the threshold of unannealable damage is reached. Because of the physical effects of γ radiation on silicon, it is expected that the annealing should be at least as effective as for electron irradiation. With proton damage, the annealing does not attain the same degree of completeness as in electron irradiation, but for the most severe case of low-energy proton irradiation (0.1 to 0.5 MeV), a 25-μ-thick glass cover provided adequate protection. In general, thermal annealing is the only method now known by which 20% of solar-cell damage can be reduced repeatedly to zero. Several models for annealing in the space environment are proposed, one of which is based on the greenhouse effect and uses solar heating directly. This system requires a satellite with special orientation during the annealing. Another system uses a collapsible panel and direct electric heating from a storage source or from other solar panels in operation. (BBB)

24420 INFLUENCE OF CRYSTAL LATTICE ON MOTION OF ENERGETIC CHARGED PARTICLES. Lindhard, Jens. Kgl. Dan. Vidensk. Selsk., Mat.-Fys. Medd., 34: No. 14, 64p(1965).

A theoretical treatment of some problems of directional effects for energetic charged particles moving through solids is presented. The fundamental approximations of the description are stated and the simple concept of a chain or string of atoms is introduced. A transverse continuum potential is a natural consequence of the basic approximations. The limit of applicability of continuum potentials is given by a critical angle. At high particle energies the critical angle is of simple type. The critical angle separates particles behaving essentially as in a random substance from particles that do not come close with corresponding reduction of most physical processes. Some examples are discussed, and critical angles belonging to atomic planes, strings, and pairs are compared. Characteristic features of a quantitative treatment are sketched. Basic statistical estimates in calculations of directional effects are considered. As a function of transverse energy, E_1, deceleration is calculated for electronic nuclear collisions. Multiple scattering, i.e., lack of conservation of transverse energy, was studied. The normal multiple scattering, due to nuclear collisions, is markedly reduced for low values of E_1. Experiments on directional effects are discussed from a theoretical point of view, and the main effects to be taken into account are summarized. The order of magnitude of dip minima is estimated. A more detailed investigation of classical deflections by lattice atoms, and the limits of validity of continuum potentials, is given in an appendix where also critical angles of particle emission from perfect strings are estimated. Quantitative corrections to the classical description are studied, and it is found that the corrections are small at high velocities. (BBB)

24421 RECOMBINATION RADIATION IN GaAs EXCITED WITH FAST ELECTRONS. Domanevskii, D. S.; Tkachev, V. D. (Lenin Belorussian State Univ., Minsk). Sov. Phys.-Semiconduct. (Engl. Transl.), 1: 310-14(Sept. 1967).

The recombination radiation spectra, excited with a 50-keV electron beam was studied in GaAs of n- and p-type, prepared by various methods and specially doped with chemical impurities (Fe, Ni, Cr, Zn) during growth. A shift of the edge luminescence toward low energies was observed in p-type GaAs doped with Zn, and was ascribed to the capture of nonequilibrium electrons by Zn levels, which broadened into an impurity band as the concentration of Zn increased. The influence of some compensating impurities on the radiative transitions in GaAs was analyzed. The resulting spectra did not contain any new bands compared with the uncompensated n- and p-type material. A characteristic feature of these spectra was the relatively weak intensity of the short-wavelength bands, compared with the impurity bands, while the uncompensated material exhibited a reverse relation. According to one model, compensation in GaAs may take place because of an excess of deep acceptors, which are electron-capture centers. Consequently, the reduction in the intensity of the short-wavelength radiation may be explained by the similar capture of nonequilibrium electrons. The similarity of the spectral curves with those of the uncompensated samples indicated that this capture can be nonradiative. On the other hand, the changes in the relations between the intensities of individual impurity bands may be due to the capture of excess electrons or due to a reduction in the concentration of recombination centers. Nickel activated a new radiative center in GaAs, and the effect was probably similar to that of high-energy electron irradiation of Si. (BBB)

24422 THE MOESSBAUER SPECTRA OF SULPHO-SPINELS CONTAINING Fe^{2+} IONS. Yagnik, C. M.; Mathur, H. B. (National Chemical Lab., Poona, India). Solid State Commun., 5: 841-4(Nov. 1967).

The Moessbauer spectra of sulpho-spinels $FeCr_2S_4$ and $FeIn_2S_4$ were studied. $FeCr_2S_4$ shows a single-line resonance spectrum with an isomer shift of 0.72 mm/sec with respect to stainless steel at 25°C. $FeIn_2S_4$ at −194°C has an isomer shift of 0.90 mm/sec and a quadrupole splitting of 3.12 mm/sec, which may be attributed to the presence of the trigonal field at the octahedral site in the spinel structure. (auth) (UK)

24423 MOESSBAUER STUDY OF THE ELECTRONIC AND MAGNETIC PROPERTIES OF Fe^{2+} IONS IN SOME SPINEL-TYPE COMPOUNDS. Hartmann-Boutron, F. (Faculte des Sciences, Orsay, France); Imbert, P. J. Appl. Phys., 39: 775-85(Feb. 1, 1968).

The results and interpretation of some Moessbauer experiments on $FeCr_2O_4$, FeV_2O_4, and $GeFe_2O_4$ are discussed. A detailed study of the thermal variation of the spectra leads to a determination of both quadrupolar coupling and hyperfine field at the ^{57}Fe nucleus as a function of temperature. Knowing the local symmetry around the Fe^{2+} ion, which is tetragonal in the first two cases, and trigonal in the last one, it is possible to deduce from the quadrupolar coupling the form of the lowest orbital wave function of the Fe^{2+} ion. In $FeCr_2O_4$ and FeV_2O_4, this may be combined with the optical data obtained by Slack on the very similar compound $FeAl_2O_4$, to predict the form and magnitude of the spin Hamiltonian and magnetic anisotropy, as well as that of the hyperfine field tensor (using a reasonable estimate for the core hyperfine field). In $GeFe_2O_4$ similar predictions can be made after deducing the distance to the first excited orbital level from the thermal variation of e^2qQ. The interest of such calculations in connection with the determination of the magnetic structures and properties of these types of compounds is examined. (auth)

24424 MOESSBAUER EFFECT IN YTTRIUM- AND IN SAMARIUM-IRON GARNETS. van Loef, J. J. (Reactor Instituut, Delft, Netherlands). J. Appl. Phys., 39: 1258-60(Feb. 1, 1968).

Magnetic hyperfine fields and electric quadrupole splittings at the tetrahedral (D) and octahedral (A) iron sites in powdered samples of YIG and SmIG have been measured by means of the Moessbauer effect at various temperatures between 85 and 600°K. From the room-temperature Moessbauer spectra it follows that in YIG the magnetization is along the [111] axis, whereas in SmIG the magnetization is in the [110] direction. In SmIG, a Curie temperature of 573.4 ± 0.3°K has been found. From a comparison of the resultant moment of the iron sublattices with the total magnetization of SmIG as measured by Geller et al., a crossover near 300°K is apparent. (auth)

24425 TEMPERATURE DEPENDENCE OF THE MAGNETIC MOMENT AND EFFECTIVE HYPERFINE FIELD OF Sm^{3+} IN SmIG. Nowik, I. (Yale Univ., New Haven); Ofer, S. J. Appl. Phys., 39: 1252-3(Feb. 1, 1968).

The experimental temperature dependences of the magnetic hyperfine field [$H_{eff}(T)$] and the ionic magnetic moment [$M_s(T)$] of Sm^{3+} in SmIG are compared with theoretical predictions. A Hamiltonian, which includes spin orbit energy splittings, the exchange interaction, and a fourth-order cubic crystalline-field potential, was diagonalized within the 14 levels of $H_{\frac{5}{2}} + H_{\frac{7}{2}}$. $H_{eff}(T)$ and $M_s(T)$ were calculated for various values of the exchange field H_{exch} at 0°K and the crystalline-field constant (B_4). Fairly good agreement with experimental temperature dependences of both M_s and H_{eff} is obtained with $B_4 = 485\ cm^{-1}$ and $\beta_0 H_{exch}$ (0°K)/k = 32°K. (auth)

24426 EXCHANGE INTERACTIONS IN RARE EARTH IRON GARNETS. Atzmony, U.; Bauminger, E. R.; Einhorn, B.; Hess, J.; Mustachi, A.; Ofer, S. (Hebrew Univ., Jerusalem). J. Appl. Phys., 39: 1250-1(Feb. 1, 1968).

The exchange magnetic fields at Eu ions inside various rare earth iron garnets were estimated from measurements of the splittings of the 103-keV Moessbauer line of ^{153}Eu. Moessbauer sources of the composition $(M_{0.975}{}^{153}Sm_{0.025})_3Fe_5O_{12}$ were prepared with radioactive Sm_2O_3 and an absorber of Eu_2O_3 was used. The splittings for diamagnetic Lu and Y were the same although the atomic cell sizes of YIG and LuIG differ by ~1%. This indicates that the rare-earth iron-exchange interaction in the garnets is not very sensitive to the cell sizes of the garnets. For Gd the splitting was (8.0 ± 1.5)% smaller than for Lu or Y, showing that the exchange field (at the Eu ions) produced by the Gd ions is about 8% of the field produced by the Fe ions. The Eu^{3+}-rare-earth exchange interactions were found to be approximately proportional to $\langle S \rangle = (g - 1)\langle J \rangle$. (auth)

24427 MOESSBAUER MEASUREMENTS IN ZnY ($Ba_2Zn_2Fe_{12}O_{22}$) AND $Mn_{0.025}$-ZnY FERRITES. Albanese, G.; Asti, G.; Lamborizio, C. (Univ., Parma, Italy. Gruppo Nazionale Struttura della Materia, Parma, Italy). J. Appl. Phys., 39: 1198-9(Feb. 1, 1968).

By means of the Moessbauer technique, the hyperfine magnetic fields and the electric quadrupole interactions in ZnY ($Ba_2Zn_2F_{12}O_{22}$) and $Mn_{0.025}$-ZnY planar ferrites have been investigated. From the obtained spectra it is deduced that the Zn ions are randomly distributed over the tetrahedral sites of both S and T blocks and that Mn is substituting for Fe^{3+}. The magnetic transition temperature for $Mn_{0.025}$-ZnY turns out to be $T_C = (143 \pm 5)°C$, not much different from that of ZnY, where $T_C = 135 \pm 5°C$. In these compounds the angle between the magnetic moment and the electric-field gradients differs from 90° showing the presence of angles between the magnetic moments of iron ions. (auth)

24428 MOESSBAUER EFFECT IN SEVERAL COPPER-MANGANESE FERRITES. Bunget, I.; Rusu, M.; Andreescu, N.; Nistor, C. An. Univ. Bucuresti, Ser. Stiint. Natur., Fiz., 14: 9-13(1965). (In Rumanian).

A few outstanding peculiarities of the electric properties of $Cu_x\ Mn_{1-x}\ Fe_2O_4$ ferrites have been attributed to cation distribution, migration of part of the copper ions between the tetrahedral and octahedral lattices, etc. From the study of the magnetic and quadrupolar splitting of the 14.4-keV level in ferrite ^{57}Fe for x = 0.2, 0.6, 0.9 and 1, an ever-growing tendency of the magnetic field to become stronger from 4.39×10^5 to 5.02×10^5 Oe at higher densities has been ascertained. According to the authors, this variation is accounted for by the higher Fe^{2+} ionic strength. (Romanian Sci. Abstr.)

24429 RADIATIVE RECOMBINATION IN GaAs WITH RESIDUAL AND RADIATION DEFECTS. Tkachev, V. D.; Domanevskii, D. S.; Lomako, V. M.; Stel'makh, V. F. (Belorussian State Univ., Minsk). Fiz. Tekh. Poluprov., 1: 986-9(1967). (In Russian).

Earlier work dealing with recombination radiation in GaAs excited by fast electrons is continued. The present study is devoted to excitation with gamma quanta from ^{60}Co and excitation by fast reactor neutrons. The irradiation with the gamma quanta was at 20°C, and with neutrons at 70°C, and the integral radiation fluxes were 3.6×10^{15}—5×10^{17} quanta/cm² and 10^{13}—10^{17} n/cm², respectively. The recombination radiation was investigated with the same setup as in the earlier study. Excitation with fast electrons of 50 keV energy was used to excite the nonequilibrium carriers. The latter revealed the presence with bands with maxima at 1.508, 1.21, and 0.96 eV at 80°K. Irradiation with the gamma quanta or fast neutrons caused redistribution of the intensities of the individual bands, and produced a new band at 1.35 eV, which is attributed to electron capture by the arsenic vacancies produced by the irradiation. Plots of the recombination radiation against the exciting-particle fluxes and the recombination-radiation are presented. The observed shift of the edge radiation of 1.508 eV with increasing irradiation flux is attributed to the transfer of Si and C impurities from the Ga vacancies to the As vacancies. It is concluded that irradiation produces very complicated changes in the gallium arsenide, which call for further study. (ATD)

24430 LOW-ENERGY IRRADIATION OF GERMANIUM SINGLE CRYSTALS BY He^+ AND Xe^+ INERT GAS IONS. Tishchenko, V. D. Fiz. Tekh. Poluprov., 1: 1577-9(1967). (In Russian).

An experimental investigation was made of the characteristics of structural damage to the faces of Ge single crystals by low-energy He^+ and Xe^+ ion bombardment. One of the faces of a cube-form target was subjected to a flux of bombarding ions. The pressure of residual gases in the sealed-off glass tube was about $5\ 10^{-9}$ Torr after the admission of the pure inert gas which served as the ion source. Radioactive indicators were used to measure the material separated from the surface of the target. The activation of the targets by the ^{71}Ge isotope was carried out by neutron flux in the VVR-M reactor of the institute of Physics UkrSSR. The yield of germanium atoms knocked out of the [111] face by the inert gas ions of varying energy (from about 50 eV down to 5 eV) shows two parts of differing steepness, the steeper part corresponding to higher energies. At a constant energy (21 eV) of Xe^+ ions directed onto the [100] and [110] faces, a considerable drop of the yield in time was observed, which started to level off after about 40 min of irradiation. The yield drop was much more pronounced on the [110] face. Markedly different yield characteristics were obtained when the ion energy was varied upward under good vacuum conditions and after a careful heat treatment of the specimens. Here, the yield as a function of ion energy acquired linearity and a constant steepness which makes it possible to judge the breakoff energy of the atoms under bombardment by a given type of ions. As a function of time, the yield under these conditions remained practically constant. The observed facts, the author suggests, should cause a reevaluation of known experimental data concerning the atom yield of certain substances, especially under fluxes of low- and medium-energy ions. (auth)

24431 RECOMBINATION EMISSION IN SILICON SINGLE CRYSTALS IRRADIATED BY FAST NEUTRONS. Bortnik, M. V.; Tkachev, V. D.; Yukhnevich, A. V. (Belorussian State Univ., Minsk). Fiz. Tekh. Poluprov., 1: 959-60(1967). (In Russian).

The results of an investigation of the spectra of recombination emission in silicon single crystals irradiated by fluxes of fast neutrons. The specimens used in the experiment were made of n-type silicon with a resistivity of 100 ohm·cm. The nonequilibrium carriers were excited by a short-wave light, while the specimens were irradiated by fast reactor neutrons at a temperature of 70°C. The distinctive feature of the emission spectra in the impurity region of the specimens is the presence of a band 0.15-eV wide with a maximum of 0.78 eV (resolution, 0.02 eV). The intensity of the band sharply decreases with an increase in temperature of 90 to 125°K. The impurity bands A (0.967 eV) and B (0.488 eV) were also observed in the spectrum. Based upon the results from the experiment, the following conclusions were reached: (1) Irradiation by relatively weak fluxes of fast neutrons (up to $10^{13} cm^{-2}$) and γ quanta leads to development of the same centers of recombination emission, which do not determine the lifetime of nonequilibrium carriers because the annealing of the corresponding impurity bands does not lead to any perceptible restoration of the self-emission band. (2) The difference in the intensity of the emission bands in specimens irradiated by fast neutrons and by γ quanta (with equal relative drops in the self-emission intensity) is illustrated by the greater development efficiency of centers of recombination nonemission during the neutron irradiation. (3) During irradiation by fast neutron fluxes higher than $10^{15}\ cm^{-2}$, the development speed of the centers (which are responsible for the development of bands A and B) is lower than the development speed of centers determining the lifetime of nonequilibrium carriers. This leads to an intensity drop in the impurity bands. (ATD)

24432 FAR INFRARED PROPERTIES OF LATTICE RESONANT MODES. I. ISOTOPE SHIFTS. Kirby, R. D.; Nolt, I. G.; Alexander, R. W. Jr.; Sievers, A. J. (Cornell Univ., Ithaca, N. Y.). Contract AT(30-1)-2391. Phys. Rev., 168: 1057-63 (Apr. 15, 1968). (NYO-2391-63).

The frequency shift of a lattice resonant mode associated with the isotopic substitution of an impurity ion has been measured for NaCl : Cu^+, KI : Ag^+, and KBr : Li^+. For all three systems, the experimental frequency shifts can be described satisfactorily by an Einstein oscillator representation for the resonant mode with the oscillator mass set equal to the impurity-ion mass. The model of Benedek and Nardelli and also Klein does not account for the experimental results of NaCl : Cu^+ or KBr : Li^+. The inclusion of

anharmonic forces does improve the agreement between theory and experiment, but a large discrepancy still exists for KBr : Li^+. (auth)

24433 DEPOLARIZATION OF RAMAN SCATTERING IN $LaCl_3$. Asawa, C. K.; Satten, R. A.; Stafsudd, O. M. (Hughes Research Labs., Malibu, Calif.). Phys. Rev., 168: 957-9 (Apr. 15, 1968).

The first-order Raman spectrum of $LaCl_3$ is reexamined. Consideration of depolarization of the Raman scattering from the totally symmetric A_g vibration has led to a different assignment for the Raman-active lines: 108 cm^{-1}, E_{2g}; 180 cm^{-1}, A_g; 186 cm^{-1}, E_{1g}; 212 cm^{-1}, A_g; 219 cm^{-1}, E_{2g}. The depolarization scattering appears to result from optic axis wandering in the crystal as well as from converging or diverging light beams. (auth)

24434 MAGNETIC INTERACTIONS BETWEEN RARE-EARTH IONS IN INSULATORS. I. ACCURATE ELECTRON-PARAMAGNETIC-RESONANCE DETERMINATION OF Gd^{3+} PAIR-INTERACTION CONSTANTS IN $LaCl_3$. Hutchings, M. T.; Birgeneau, R. J.; Wolf, W. P. (Yale Univ., New Haven). Phys. Rev., 168: 1026-44 (Apr. 15, 1968).

Experiments are described, which illustrate an accurate method of measuring both isotropic and anisotropic interactions between pairs of similar magnetic ions. The method is applicable whenever there are sufficient admixtures of the pair states by anisotropic interactions or crystal-field terms and the effective spin of each ion is greater than $\frac{1}{2}$. These conditions are well illustrated by Gd^{3+} neighbors in $LaCl_3$. Paramagnetic-resonance measurements at 25 and 9 GHz have been made on crystals of $LaCl_3$ containing about 1% Gd^{3+} at temperatures between 1.6 and 360°K, and a large number of weak lines have been identified as due to transitions in isolated nearest-neighbor and next-nearest-neighbor pairs. Detailed analyses of both spectra show that the interactions for both types of pairs are well represented by isotropic (Heisenberg) terms $JS_1 \cdot S_2$, plus magnetic-dipole coupling appropriate to the separation between the neighbors. For the nearest neighbors $J_{nn} = 0.01330$ cm^{-1} (antiferromagnetic) at 20°K, decreasing to 0.01254 cm^{-1} at 360°K; while for the next-nearest neighbors $J_{nnn} = -0.0602$ cm^{-1} (ferromagnetic) at 20°K increasing to -0.0532 cm^{-1} at 360°K. (Below 20°K somewhat increased linewidths precluded accurate measurements, but the parameters appeared to remain virtually unchanged.) Neither the magnitudes nor the signs of these values can be explained by present superexchange theories, but they are in generally good agreement with values deduced from the bulk properties of concentrated $GdCl_3$, and they resolve an ambiguity in the earlier analyses. The observed magnetic-dipole interaction parameters are also found to vary somewhat with temperature, and this may be used to estimate changes in the mean separation between neighbors due to thermal expansion. These estimates may then be combined with the observed temperature variations of the J's to deduce approximate separation dependences for J_{nn} and J_{nnn}. Both are found to be very marked ($\sim r^{13}$ and r^{22}, respectively) and appreciably more rapid than the recently proposed tenth-power law for superexchange. (auth)

24435 ELECTRON SPIN RESONANCE OF TRIPOSITIVE CURIUM IN ThO_2 AND CeO_2. Abraham, M. M.; Finch, C. B.; Clark, G. W. (Oak Ridge National Lab., Tenn.). Contract W-7405-eng-26. Phys. Rev., 168: 933-5(Apr. 15, 1968). (ORNL-P-3542).

The ESR spectra of $^{244}Cm^{3+}$-doped ThO_2 and CeO_2 single crystals were measured at approximately 10 Gc/sec and liquid-helium temperatures. Sites of cubic symmetry were observed in both hosts, with the crystal-field splitting being larger than the microwave quanta used. The ground states are Γ_6 doublets, indicating that the fourth-order parameter of the cubic crystal-field Hamiltonian is negative. For ThO_2, the g value was 4.484 ± 0.002, and for CeO_2, it was 4.475 ± 0.002. (auth)

24436 ELECTRONIC STRUCTURE OF RARE-EARTH METALS. II. POSITRON ANNIHILATION. Williams, R. W. (Ames Lab., Iowa); Mackintosh, A. R. Phys. Rev., 168: 679-86 (Apr. 15, 1968).

The angular correlation of the photons emitted when positrons annihilate with electrons has been studied in single crystals of the rare-earth metals, Y, Gd, Tb, Dy, Ho, and Er, and in a single crystal of an equiatomic alloy of Ho and Er. A comparison of the results for Y with the calculations of Loucks shows that the independent-particle model gives a good first approximation to the angular distribution, although correlation effects probably smear out some of the structure. The angular distributions from the heavy rare earth metals are very similar to that from Y and can be understood qualitatively in terms of the relativistic augmented-plane-wave calculations by Keeton and Loucks. The angular distributions in the c direction in the paramagnetic phases are characterized by a rapid drop at low angles followed by a hump, and these features are associated with rather flat regions of Fermi surface normal to the c axis. The same aspects of the Fermi surface are believed to be important in determining the stability of the periodic magnetic structures formed in some of the metals, and there is a strong correlation between the structure in the angular distribution and the magnetic properties. In the spiral phase of Ho, the structure in the c-axis distribution is much reduced, indicating that the Fermi surface is substantially modified by the magnetic ordering, as expected. The photon distribution from the equiatomic Ho–Er alloy is very similar to those from the constituent metals, although the structure is somewhat more pronounced. (auth)

24437 ELECTRONIC STRUCTURE OF RARE-EARTH METALS. I. RELATIVISTIC AUGMENTED-PLANE-WAVE CALCULATIONS. Keeton, S. C.; Loucks, T. L. (Ames Lab., Iowa). Phys. Rev., 168: 672-8(Apr. 15, 1968). (IS-1666).

Relativistic augmented-plane-wave calculations for Gd, Dy, Er, and Lu are reported. Energy bands, histograms of the density of states, and Fermi-surface cross sections are given. The Fermi surface of Dy, Er, and Lu are found to be quite similar to the one given earlier for yttrium. The Fermi surface of Gd is found to differ from the others by the absence of a "webbing" feature. Nesting between the sheets of the webbing is correlated with the occurrence of periodic moment arrangements in Dy, Er, and alloys of Y and of Lu with certain magnetic rare earths. (auth)

24438 ISOTOPE EFFECT IN CRYSTAL-FIELD SPLITTING. Huang, Chao-yuan (Case Western Reserve Univ., Cleveland). Phys. Rev., 168: 334-6(Apr. 10, 1968).

The Van Vleck orbit–lattice interaction attributed to the normal coordinates of the cubic molecular cluster transforming like Γ_{4u} is used to calculate the ground-state splitting induced by the lattice vibrations. With the aid of the result obtained by Visscher, it is shown that the isotope shift in the crystal-field splitting of the ground state follows the isotope-mass-difference-ratio relationship. It is also found that the temperature-dependent part of the isotope shift is due to the quantum corrections and should vanish in the classical limit. (auth)

24439 EFFECT OF THE TRANSLATIONAL-DIFFUSION MECHANISM ON THE LOW-FIELD NMR SPIN–LATTICE RELAXATION TIME IN THE ROTATING REFERENCE FRAME: CALCULATION OF THE ORDER PARAMETER p. Ailion, David C.; Ho, Pei-pin (Univ. of Utah, Salt Lake City). Phys. Rev., 168: 662-71(Apr. 15, 1968).

The effect of the translational-diffusion mechanism on the low-field NMR spin–lattice relaxation time in the rotating reference frame is calculated for simple cubic, body-centered cubic, and face-centered cubic lattices. The results of these calculations suggest a new method for determining the preferred diffusion mechanism. Previously NMR has been able to provide a direct measurement of the activation energy only; a theory has always been needed to determine the jump frequency from the experimentally measured relaxation time. Recently Slichter and Ailion developed a new technique for the study of ultraslow diffusion, which is applicable when the mean time τ between atomic jumps is less than the spin–lattice relaxation time T_1. In their theory, an order parameter p appears in the relationship between the experimentally measured relaxation time and τ. This parameter p depends upon the diffusion mechanism and the angle θ, which describes the orientation of the crystal with respect to the external magnetic field. In this paper p versus θ was calculated for vacancy diffusion, interstitialcy diffusion, and interstitial diffusion in bcc, fcc, and sc lattices for two cases. In the first case, it was assumed that τ_i, the mean time that an interstitial atom occupies a particular site between jumps, is longer than T_2, the spin–spin relaxation time, and it was found that the angular dependence of p is quite different for different mechanisms. In the second case, it was assumed that $\tau_i < T_2$ and found that the angular dependence of p for interstitialcy diffusion differs from the vacancy results by approximately 10% for the three lattices considered. These theoretical results, when combined with experimental measurements of the angular dependence of the low-field relaxation time, provide a method for the direct determination of the mechanism responsible for diffusion in these crystals. (auth)

24440 THEORY OF ISOTOPIC EFFECTS IN THE ELECTRON–PHONON INTERACTION. Matthew, J. A. D.; Hart-Davis, A. (Univ. of York, Eng.). Phys. Rev., 168: 936-46(Apr. 15, 1968).

Experiments on hydrogen and deuterium in solid argon and on the U center in the alkali halides reveal isotopic effects in the positions and breadths of the optical absorption bands, which are inexplicable in terms of the linear approximation of the electron–phonon interaction. Quadratic effects are treated in the semi-

classical approximation with a view to understanding the relative roles of band modes and localized modes. It is found that interactions involving localized modes dominate. Further, if the isotopic effects are interpreted as being solely due to quadratic interactions, the impurity is likely to be dynamically unstable in the excited electronic state. However, estimates of anharmonic interactions indicate that these may make a significant contribution to the isotopic properties of these systems. (auth)

24441 DISPLACEMENT OF ATOMS BY A CASCADE OF FAST ELECTRONS. Lenchenko, V. M.; Chadaev, E. (Inst. of Nuclear Physics, Ulugbek, USSR). Sov. Phys.-Solid State (Engl. Transl.), 9: 2310-12(Apr. 1968).

Translated from Fiz. Tverd. Tela, 9: 2939-42(Oct. 1967).

Calculations are made of the multiplication of fast electrons in a cascade of collisions in an absorber, generated by a single primary electron, and the energy spectrum of the atoms displaced in such a cascade is determined. Numerical calculations are made for germanium bombarded by electrons having energies of 5 to 25 MeV. (auth)

24442 EFFECT OF THE EXCHANGE INTERACTION OF MAGNETIC IONS ON THE INTENSITIES OF MOESSBAUER SPECTRA. Bashkirov, Sh. Sh.; Selyutin, G. Ya. Sov. Phys.-Solid State (Engl. Transl.), 9: 2284-6(Apr. 1968).

Translated from Fiz. Tverd. Tela, 9: 2904-8(Oct. 1967).

The effect of the exchange interaction of magnetic ions on the intensity of the Mössbauer spectra is considered. It is shown that in magnetically dense crystals the exchange forces can make a measurable contribution to the intensity, depending on the value of the correlation function $(\hat{S}_i \hat{S}_j)$ ($\hat{S}_i$, $\hat{S}_j$ are the spin operators of the magnetic ions). (auth)

24443 DAMAGE IN DOUBLE-POSITIONED GOLD FILMS BOMBARDED WITH HELIUM IONS. Norden, H.; Hogberg, G.; Andreen, C. J. (Chalmers Univ. of Tech., Gothenburg, Sweden). Appl. Phys. Lett., 12: 300-2(May 1, 1968).

Double-positioned gold films of (111) orientation are used in a study of the reduction in radiation damage due to channeling. (auth)

24444 NEUTRON-DIFFRACTION STUDY AND MAGNETIC MEASUREMENTS OF FERROMAGNETIC $UFeO_4$. Bacmann, Madeleine; Bertaut, Erwin Felix; Blaise, Alain (CEN, Grenoble, France). Compt. Rend., Ser. A and B, 266: 45-8(Jan. 8, 1968). (In French).

Orthorhombic $UFeO_4$ (Pbcn) is ordered magnetically at T = 47 ± 2°K. Fe has a ferromagnetic component of about 4 μ_B according to O_Z and an antiferromagnetic component of 2 μ_B according to O_X; μ has a weak antiferromagnetic moment of about 0.4 μ_B along O_X. (tr-auth)

24445 POINT DEFECTS IN SOLIDS. Lidiard, A. B. (Atomic Energy Research Establishment, Harwell, Eng.). Sci. Progr. (Oxford), 56: 103-29(1968).

A review is presented of the structure, energies and mobilities of so-called point defects in crystalline solids, i.e., of vacant sites in the crystal lattice and of atoms in interstices of the crystal lattice. Such defects in the regular lattice may be created by thermal agitation and by irradiation of the solid with beams of particles (e.g., neutrons, protons, electrons, etc.) of sufficient energy to displace atoms by collisions with the nuclei. These processes are general and apply to all solids; in some strongly ionic compounds, however, special mechanisms allow the production of atomic displacements by low-energy photons, i.e., x rays or even uv radiation. (Point defects are also created during mechanical deformation of solids, but the primary effect in such a process is the multiplication of dislocations, i.e., linear defects in the crystal structure.) Both vacancies and interstitials may migrate through the crystal lattice as a result of thermal agitation, often at surprisingly low temperatures (e.g., in the liquid H_2 region for interstitial atoms in many materials). As a result of this high defect mobility the configuration and number of defects introduced by irradiation at, say, room temperature, is generally quite different from that following irradiation at very low temperatures. Whereas the defects formed at the lowest temperatures will be frozen into the lattice in the positions where they are created, at higher temperatures their mobility means that they either anneal out, for instance by vacancy–interstitial recombination, or aggregate to form clustered defects. Although in many materials vacancies do not migrate significantly at room temperature, there are very few in which interstitial migration is not rapid in this region. (UK)

24446 RECOVERY OF ELECTRON-IRRADIATED ZIRCONIUM AT LOW TEMPERATURES. Neely, H. H. (Atomics International, Canoga Park, Calif.). Can. J. Phys., 46: 321-4(Mar. 1, 1968).

The low-temperature recovery of the electrical resistivity of polycrystalline zirconium was measured after electron irradiation below 8°K. The material used in this irradiation was the same low oxygen material (0.015 at. %) used by Swanson to study recovery after deformation at 4.2°K. Substage I_B was found to be only of the order of 4% of the irradiation-induced resistivity change, compared to ~6% observed by Swanson after deformation. Stage I (4.2 to 160°K) in Zr contains six substages, while stage II (160 to 310°K) contains only one substage after electron irradiation. While no study of kinetics was made, it seems likely that close pair-annihilation processes are responsible for the recovery spectrum below 118°K and that longer-range defect migration occurs in the neighborhood of 140°K. (auth)

24447 RECENT DEVELOPMENTS IN NUCLEAR ACOUSTIC RESONANCE. Bowen, L. O. (Univ. of Witwatersrand, Johannesburg). Aust. Phys., 5: 26-9(Feb. 1968).

The process of nuclear acoustic resonance is briefly outlined and some examples of its use are given. (M.O.W.)

24448 FIELD EVAPORATION OF A SCREW DISLOCATION IN TUNGSTEN. Carroll, Robert W.; Schubert, Clarence C. (Fordham Univ., New York). J. Appl. Phys., 39: 2339-42 (Apr. 1968).

A complex crystal defect in tungsten has been examined in detail by means of the field ion microscope. Field evaporation has been employed to remove the metal surface, making visible the three-dimensional structure of the defect. The defect has been identified as a grain boundary appearing in $(\bar{1}16)$ of one grain and $(1\bar{1}6)$ of the other, so that the grains are misoriented by an angle of 26.5° rotation about the direction [110], which corresponds to the axis of the wire sample. A screw dislocation intersects (110), which is shared by both grains. The intersection of the screw dislocation with the surface produces a spiral on (110) which can be made to rotate under field evaporation. The direction of the Burgers vector of the dislocation has been found to be [110], and the Burgers vector magnitude is an integral multiple of the (110) plane spacing. The Burgers vector magnitude of the dislocation increases as the sample is removed, producing multiple spirals on (110). (auth)

24449 ANGULAR DEPENDENCE OF ^{19}F NUCLEAR RELAXATION TIMES IN DILUTE SrF_2:Eu^{++}. Verber, C. M.; Lecander, R. G.; Jones, W. H. Jr. (Battelle Memorial Inst., Columbus, Ohio). Phys. Rev. Lett., 20: 852-5(Apr. 15, 1968).

The ^{19}F spin–lattice relaxation time T_1 was measured in a SrF_2 single crystal doped with 0.01 at. % of Eu^{++}, as a function of the angle θ between the [100] axis and the applied magnetic field as the crystal is rotated about a [110] axis. At 4.2°K, T_1 is a strong, highly structured function of θ, varying more than an order of magnitude in an angular range of 25°. (M.O.W.)

24450 DOPING OF SILICON BY ION IMPLANTATION. Itoh, Tadatsugu; Inada, Taroh; Kanekawa, Kiyoshi (Waseda Univ., Tokyo). Appl. Phys. Lett., 12: 244-6(Apr. 15, 1968).

Radiation damages created in silicon single crystals bombarded with 10-keV aluminum ions were examined by means of electron-diffraction method. A deep penetration of aluminum ion in silicon was observed, extending to 0.58 μ. This penetration was depressed by removing the bombarded surface layer about 800 Å in thickness before annealing. From these results, the deep penetration is interpreted as a radiation-enhanced diffusion effect. (auth)

24451 MOESSBAUER MEASUREMENTS ON MAGNETIC ANISOTROPY IN THIN FILMS OF IRON. Rabinovitch, K. (Technion-Israel Inst. of Tech., Haifa); Shechter, Hanan. J. Appl. Phys., 39: 2464-6(Apr. 1968).

The Moessbauer technique was used for magnetic anisotropy measurements in thin iron films prepared under various conditions, from which complementary information can be obtained. The average direction of magnetization for two different heater geometries was found to be 58.5° and 44.5°, relative to the normal to the plane of the film. The relation of the Moessbauer results to observations by other methods is discussed. (auth)

24452 EXPERIMENTAL EVIDENCE FOR INTERSTITIAL In AND Tl IN ION-IMPLANTED SILICON. Davies, J. A.; Eriksson, L.; Mayer, J. W. (Chalk River Nuclear Lab., Ontario). Appl. Phys. Lett., 12: 255-6(Apr. 15, 1968).

Using the channeling technique for locating foreign atoms in crystals, direct experimental evidence of an irreversible motion of In and Tl atoms from substitutional to interstitial sites during the annealing of ion-implanted silicon samples was obtained. Preliminary Hall measurements indicate that a corresponding transition from p- to n-type behavior also occurs in the same temperature region—viz. 525 to 575°C. Implantation conditions were $1-3 \times 10^{14}$ ions/cm^2 at 40 keV, with the substrate at 350 to 450°C to prevent lattice disorder from accumulating. (auth)

24453 HALL COEFFICIENT OF TANTALUM CARBIDE AS A FUNCTION OF CARBON CONTENT AND TEMPERATURE. Santoro, G.; Dolloff, R. T. (Lewis Research Center, Cleveland). J. Appl. Phys., 39: 2293-6(Apr. 1968).

The Hall coefficient and the electrical resistivity of tantalum carbide were investigated along the entire cubic phase region at room temperature and at −196°C. At both temperatures the Hall coefficient was found to be negative and to decrease in magnitude with decreasing carbon content. Near the stoichiometric composition the magnitude of the Hall coefficient was lower at −196°C than at room temperature, but approached the room temperature value at about $TaC_{0.8}$. The electrical resistivity increased with decreasing carbon content at both temperatures. The magnetoresistivity was too small to be detected. (auth)

24454 ELECTRON AND ION EMISSION FROM SURFACES ORIGINALLY OF TaB_2, ZrC, Mo_2C, $MoSi_2$, $TaSi_2$, AND WSi_2 IN CESIUM VAPOR. Wilson, R. G. (Hughes Research Labs., Malibu, Calif.). J. Appl. Phys., 39: 2306-10(Apr. 1968).

Full-temperature-range electron- and ion-emission data from six refractory metal compounds in cesium vapor were obtained in the range of cesium arrival flux between 10^{13} and 10^{16} atoms/cm^2 · sec. Data are shown for ZrC and Mo_2C; the boride and the three silicides were thermally unstable at emission temperatures, resulting in nonreproducible emission in some cases. Electron-emission S curves and the cesium surface-ionization critical-temperature envelopes are shown. (auth)

24455 NUCLEAR MAGNETIC RESONANCE AND SUSCEPTIBILITY MEASUREMENTS IN TiCo. West, G. W. (Univ. of Melbourne). J. Appl. Phys., 39: 2213-5(Apr. 1968).

Nuclear magnetic resonance and magnetic susceptibility measurements have been made at 295 and 77°K on titanium−cobalt alloys over a range of composition near the equiatomic value and also on ternary alloys near the composition Ti_2NiCo. The measurements in TiCo suggest that there may be a small range of solid solution for cobalt-rich alloys near the equiatomic composition. There is a large positive Knight shift for the ^{59}Co resonance in all TiCo alloys. The Knight shift and the susceptibility are substantially larger at the lower temperature presumably due to a large contribution from an orbital interaction. For the ternary compounds both the Knight shift and the susceptibility are smaller, and it is postulated that the orbital contribution has been eliminated. (auth)

24456 LINE PROFILES IN THE NUCLEAR MAGNETIC RESONANCE AND MOESSBAUER EFFECT OF $TiFe_{1-x}Co_x$ ALLOYS. Swartzendruber, L. J.; Bennett, L. H. (National Bureau of Standards, Gaithersburg, Md.). J. Appl. Phys., 39: 2215-20(Apr. 1968).

The ^{57}Fe Moessbauer effect (ME) and the ^{59}Co nuclear magnetic resonance (NMR) have been investigated as a function of alloy concentration, temperature, and stoichiometry in $TiFe_{1-x}Co_x$ alloys over most of the range $0 \leq x \leq 1$. At room temperature, in carefully prepared samples, a single ^{57}Fe ME line was observed for all values of x. This line broadened somewhat at low temperatures, although the magnetic properties of these alloys would have led one to expect a larger broadening at certain compositions. The ^{59}Co NMR linewidth was narrowest for x close to 0 or 1 and was a strong function of x as well as of temperature and magnetic field. The intermediate compositions displayed resolved satellite structures. Annealing reduced both the ME and NMR linewidths. Deviations from stoichiometry and internal oxidation were readily observable from their effect on the ME line profile. Comparisons are made with $TiFe_2$ and stainless steel ME spectra. Both the ME and NMR results for $TiFe_{1-x}Co_x$ are consistent with a CsCl structure over the entire composition range. The NMR results indicate a lack of atomic ordering on the Co, Fe sublattice. (auth)

24457 COMPUTER PROGRAM FOR THE EVALUATION OF COMPLEX SPECTRA. Gavron, A.; Kedem, D.; Rothem, T. (Israel Atomic Energy Commission, Yavne). Nucl. Instrum. Methods, 61: 213-16(May 1968).

A method is described by which a complex-shaped spectrum represented by experimental data can be decomposed into standard spectra, also represented by experimental data. No use is made of empirical or theoretical shape functions. The method is especially suitable for the analysis of complex Moessbauer absorption spectra. The equations are readily adapted for computer programming. (auth)

24458 SURFACE IONIZATION. III. THE FIRST IONIZATION POTENTIALS OF THE LANTHANIDES. Hertel, G. R. (Oak Ridge National Lab., Tenn.). J. Chem. Phys., 48: 2053-8(Mar. 1, 1968). (ORNL-P-3454).

The surface ionization comparison technique was used to measure the first ionization potentials (IP) of the lanthanide elements. Values obtained were La, 5.55 ± 0.05 eV; Ce, 5.54 ± 0.06; Pr, 5.40 ± 0.05; Nd, 5.49 ± 0.05; Sm, 5.61 ± 0.05; Eu, 5.64 ± 0.05; Gd, 6.16 ± 0.05; Tb, 5.89 ± 0.04; Dy, 5.82 ± 0.03; Ho, 5.89 ± 0.03; Er, 5.95 ± 0.03; Tm, 6.03 ± 0.04; Yb, 6.04 ± 0.04; and Lu, 5.32 ± 0.05. The IP of Pm is estimated to be 5.55 eV. The reference element used was silver. A tabulation of all known reported values is included, and comparisons are made. Agreement is generally good. (auth)

24459 ZERO-FIELD SPLITTINGS OF Am^{3+} AND Cm^{3+} IN CUBIC SYMMETRY SITES IN CaF_2. Edelstein, N.; Easley, W. (Univ. of California, Berkeley). J. Chem. Phys., 48: 2110-15 (Mar. 1, 1968). (UCRL-17855).

The g-value anisotropies of the ground crystal-field states of the nominally $^8S_{\frac{7}{2}}$ ions, Am^{2+} and Cm^{3+}, have been measured in cubic symmetry in CaF_2 at 35 Gc/sec and magnetic fields of approximately 5500 G by EPR spectroscopy. From the magnitude of these anisotropies the $\Gamma_6-\Gamma_8$ zero-field splittings of 13.4 ± 0.5 and 18.6 ± 0.5 cm^{-1} have been deduced for Cm^{3+} and Am^{2+}, respectively. These splittings are about 250 times greater than for the corresponding lanthanides, Gd^{3+} and Eu^{2+}. It is shown that the large intermediate coupling effects in the actinide ions can account qualitatively for these differences. (auth)

24460 DYNAMIC NUCLEAR POLARIZATION (THE SOLID-STATE EFFECT) ASSOCIATED WITH ASYMMETRIC ESR SPECTRA IN POLYCRYSTALS. Richardson, Ralph J.; Jacobsmeyer, Vincent P.; Lee, Sook (St. Louis Univ.). J. Chem. Phys., 48: 2115-17(Mar. 1, 1968).

A qualitative investigation has been made of the behavior of the dynamic nuclear polarization arising from the solid-state effect in polycrystalline substances containing paramagnetic centers for which the g and/or hyperfine tensor is substantially anisotropic. For nearly all the cases considered, the dynamic nuclear polarization and the resultant NMR enhancement will be proportional to the shape of the first derivative curve of the polycrystalline ESR spectrum. The theoretical maximum enhancement obtainable in single-crystal samples is expected to be reduced in the corresponding polycrystal samples due to the anisotropy in the g and/or hyperfine tensor. Experiments were carried out to measure ^{23}Na NMR enhancements in powdered NaCl crystals by saturating the $Cl_2^-(V_k)$ ESR spectrum, and the experimental results were found to be in good agreement with the prediction. (auth)

24461 THEORETICAL DESCRIPTION OF PERIODICALLY PULSED NUCLEAR MAGNETIC DOUBLE RESONANCE. Gordon, Sidney L. (Georgia Inst. of Tech., Atlanta). J. Chem. Phys., 48: 2129-42(Mar. 1, 1968).

Periodically pulsed nuclear magnetic double resonance is described by the Bloch equations for a single nucleus of spin ½, and by the density matrix master equation for A_mX_n spin systems. In this experiment, the observing rf field H_1 and the strong rf field H_2 are periodically pulsed so that H_1 is on when H_2 is off, and off when H_2 is on. The H_1 and H_2 pulse intervals are each equal to τ seconds. The Bloch-equation description illustrates the basic features of the experiment in terms of the macroscopic moment. This description provides a physical model for the production of double-resonance signals in the limit of short τ. The density-matrix analysis separates into two parts: the production of population changes by H_2; and the production of detected signals by H_1. The formalism is illustrated by the AX_2 system, 1, 1, 2-trichloroethane. Theoretical and experimental frequency-sweep spectra are compared for values of τ ranging from 1.25 to 0.0315 sec. The spectra are dynamic in the sense that the detector output is periodic in time with a period of 2τ. The theoretical spectra are computed by assuming that the nuclear spin system is in a quasi-steady state, and that the recorder pen swings between the maximum and minimum values of the detector output. The population changes caused by H_2 are complicated functions of τ. When τ = 1.25 sec, the spectra approximate periodically pulsed single resonance with the inclusion of the nuclear Overhauser effect. When τ = 0.0315 sec, the spectra approximate steady-state double resonance corresponding to H_1 and H_2 having one-half their amplitudes. The spectra for intermediate values of τ are complicated, and display a variety of unusual spectral features. (auth)

24462 OPTICAL ABSORPTION AND FLUORESCENCE SPECTRA OF Dy^{3+} IN LaF_3. Fry, J. L. (Louisiana State Univ., Baton Rouge. Corona Labs., Calif.); Caspers, H. H.; Rast, H. E.; Miller, S. A. J. Chem. Phys., 48: 2342-8(Mar. 1, 1968).

The absorption spectrum of Dy^{3+} ($4f^9$) in LaF_3 has been observed at 77° and 4.2°K in the 3000- to 30,000-Å wavelength region. The fluorescence spectrum was observed in the range from 4500 to 11,000 Å. From an analysis of the observed transitions, it was possible to assign J + ½ Stark components for most of the states below 24,000 cm^{-1}. The intermediate coupling free-ion energy levels for Dy^{3+} have been calculated including the interactions of all the multiplets of the $4f^9$ configuration. The final least-squares fit, with the inclusion of configuration interaction, gave a mean error of 25 cm^{-1} with the following values for the parameters: F_2 = 436.5, F_4 = 64.12, F_6 = 6.566, ζ = 1930, α = 28.85 cm^{-1}. The calculated energy levels and wave functions below 40,000 cm^{-1} are presented and discussed. (auth)

24463 EMPIRICAL DECAY LAW FOR X-RAY INDUCED LUMINESCENCE OF CALCITE. Luthra, J. M.; Gupta, N. M. (Bhabha Atomic Research Centre, Bombay). Indian J. Pure Appl. Phys., 5: 488(Oct. 1967).

The observed decay curves can be resolved into two exponential components that, when combined, reproduce the original curves. The decay corresponds to the relation: $I = 88e^{-0.053t} + 12e^{-0.0135t}$. (auth)

24464 COLOUR CENTERS INDUCED BY Cd ADDITION IN SODIUM CHLORIDE. Cappelletti, R. (Univ., Parma, Italy). Nuovo Cim., 54B: 233-44(Apr. 11, 1968).

Several absorption bands, associated to Cd doping, appear in NaCl:$CdCl_2$ system x-irradiated after quenching. Fast precipitation processes are detected for the "bases" of Cd centers responsible for the absorption bands. In light of these results, the low rate of F-center production in x-irradiated Cd-doped samples is discussed. The optical and thermal treatments effects are examined in order to analyze the nature of Cd centers. (auth)

24465 HYPERFINE MAGNETIC FIELDS AT THE ^{57}Fe NUCLEI IN $SrFe_{12-x}Ga_xO_{19}$. Albanese, G. (Univ., Parma, Italy. Gruppo Nazionale di Struttura della Materia, Parma, Italy); Asti, G.; Batti, P. Nuovo Cim., 54B: 339-40(Apr. 11, 1968).

The Mössbauer spectra were measured using an electromagnetic vibrator system associated to a multichannel analyzer working in multi-scaler mode. The source (^{57}Co in Cu) and the polycrystalline absorber ($SrFe_{12-x}Ga_xO_{19}$ with x = 0,1) were maintained at room temperature. The ^{57}Fe 14.4 keV γ-radiation was detected by means of a Xe-CH_4-filled proportional counter. The compounds were prepared by firing stoichiometric amounts of $SrCO_3$, Fe_2O_3 and Ga_2O_3 at a temperature of 1200°C for 50 hours milling and subsequent heating for 400 hours at 1400°C. The equilibrium conditions reached during preparation were verified by Röntgen analysis. (M.O.W.)

24466 MAGNETIC SUSCEPTIBILITY OF THORIUM CARBIDES, NITRIDES, AND CARBONITRIDES. Aronson, S.; Auskern, A. B. (Brookhaven National Lab., Upton, N. Y.). J. Chem. Phys., 48: 1760-5(Feb. 15, 1968). (BNL-11752).

The magnetic susceptibility of thorium carbides, nitrides, and carbonitrides has been measured at temperatures of −190°, −76°, and 22°C. All the compositions exhibited a small, temperature-independent paramagnetism. The data are compared with the results of electrical-property measurements on these compounds. It is concluded that, whereas the electrical properties are primarily determined by the conduction electrons, the magnetic susceptibility is primarily a property of the holes in the band structure. (auth)

24467 TEMPERATURE-DEPENDENT CRYSTAL FIELD EFFECTS IN THE SPIN-WAVE SPECTRUM OF TERBIUM. Brooks, M. S. S.; Goodings, D. A.; Ralph, H. I. (Univ. of Sussex, Brighton, Eng.). J. Phys., C, 1: 132-45(Feb. 1968).

A variational principle for the free energy is applied to the Hamiltonian for terbium in the ferromagnetic region to study the effect of interactions among spin waves having their origin in the strong crystalline electric fields. At high temperatures this crystal-field renormalization has the effect of multiplying the crystal-field parameters appearing in the spin-wave energies of the noninteracting theory by powers of the reduced magnetization. These powers are found to be close to those associated with the corresponding magnetic anisotropy coefficients. This leads to an appreciable temperature dependence of the spin-wave energies, which, after allowing for exchange renormalization, appears to be in reasonable agreement with the inelastic-neutron-scattering results of Møller and Houmann. The ferromagnetic resonance measurements of Bagguley and Liesegang and of Stanford and Young were also analyzed and found to be consistent with this picture. (auth) (UK)

24468 NOTE OF MOESSBAUER FRACTION IN POWDERS OF SMALL PARTICLES. van Wieringen, J. S. (Philips Research Labs., Eindhoven, Netherlands). Phys. Lett., 26A: 370-1(Mar. 11, 1968).

In powders the particles may be so small that a single particle is unable to give a "recoilless" Moessbauer transition; hence the Moessbauer fraction should depend on the degree of packing. This has been confirmed experimentally for iron oxide powders. (auth)

24469 INFLUENCE OF THE SCATTERING LAW ON THE RADIATION DAMAGE DISPLACEMENT CASCADE. II. Robinson, Mark T. (Oak Ridge National Lab., Tenn.). Phil. Mag., 17: 639-42(Mar. 1968). (ORNL-P-3474).

The asymptotic solution to the integral equation describing the radiation damage displacement cascade is derived under weaker assumptions than made previously. The results of the earlier calculation were completely confirmed, even for inverse power scattering laws having infinite total scattering cross sections, as long as the stopping cross sections are finite. (auth) (UK)

24470 EXPERIMENTS RELATING TO THE EFFECT OF IMPURITIES ON F-CENTRE PRODUCTION IN ALKALI HALIDES. Pooley, D. (Atomic Energy Research Establishment, Harwell, Eng.). J. Phys., C, 1: 323-32(Apr. 1968).

Experiments were carried out to decide whether impurities inhibit F-center production by ionizing radiation by acting as centers for electron V_k-center recombination or by reducing the stability of F centers once formed. The growth of the F band during electron irradiation, and its decay following irradiation, were measured, using single radiation pulses and continuously switched beams. It was found that none of the observed decay processes can account for the inhibition of coloration, and the evidence suggests that impurities act principally as electron V_k recombination centers. (auth) (UK)

24471 MOESSBAUER EFFECT IN THE HEUSLER ALLOY Co_2MnSn. Williams, J. M. (Univ. of Sheffield, Eng.). J. Phys., C, 1: 473-7(Apr. 1968).

The hyperfine fields at ^{119}Sn nuclei in ordered Co_2MnSn were measured using the Moessbauer effect. The field values obtained are compared (i) with other measurements on Co_2MnSn which are in disagreement, and (ii) with hyperfine fields reported for other similar Heusler alloys. A value of +0.67 ± 0.01 nuclear magnetons was obtained for the nuclear magnetic moment of the first excited state of ^{119}Sn. (auth) (UK)

24472 LOW FREQUENCY MOTIONS IN POLYMERS AS MEASURED BY NEUTRON INELASTIC SCATTERING. Safford, G. J.; Naumann, A. W. (Union Carbide Corp., Tuxedo, N. Y.). Fortschr. Hochpolym.-Forsch., 5: 1-27(1967).

Theory, instrumentation, and applications of neutron inelastic scattering are reviewed. Neutron inelastic scattering spectroscopy is a relatively new technique that is being used to study low-frequency molecular motions in polymers. It provides good resolution between 1000 and 10 cm^{-1} and is not limited by optical selection rules. Thus, all vibrations with characteristic periods less than the interaction time of neutrons (about 10^{-12} sec) are observed. Neutron spectroscopy makes use of the property that low-energy neutrons, when scattered by a sample, can gain or lose increments of energy that are characteristic of the molecular vibrational frequencies of the sample. The incident neutrons are selected to have a narrow distribution of energies and an average energy comparable to that of the low-frequency motions of the molecules of the scattering medium. At these energies, the wavelengths of the neutrons are comparable to atomic spacings. Under these conditions, the energy transfers in neutron-molecule collisions correspond to the energies of phased vibrations of adjacent atoms in the sample lattice, and are large compared to the energy spread of the incident beam. (BBB)

24473 DEVICE FOR OBSERVING NUCLEAR MAGNETIC DOUBLE RESONANCE ^1H–^{31}P AND ^{19}F–^{31}P BY MEANS OF SPECTROMETERS WITH A FREQUENCY OF 40 MHz. Lebedev, V. B.; Ionin, B. I. (Leningrad Technological Inst.). Izv. Vyssh. Ucheb. Zaved., Priborostr., 10: 29-33(1967). (In Russian).

A device is proposed for disrupting the spin–spin bond of the ^1H or ^{19}F nuclei with the ^{31}P nucleus when recording the spectra of nuclear magnetic resonance by means of spectrometers with an operating frequency of 40 MHz. The device provides for a maximum induction of a 4 G high-frequency magnetic field in the sample. The frequency is controlled from 15.3 to 17.6 MHz in 3 steps achieved by varying the capacity and inductance of the tank circuit as well as the capacity of the diode. The latter variation is achieved by a biasing dc voltage. Figures are presented showing the spectrum of proton resonance obtained by means of the device. The device makes it possible to achieve double resonance with high stability and with a uniform frequency control. (ATD)

24474 A STUDY OF VERY SMALL DEFECT CLUSTERS IN IRRADIATED MAGNESIUM OXIDE, USING LONG-WAVELENGTH NEUTRON SCATTERING MEASUREMENTS. Martin, D. G. (Atomic Energy Research Establishment, Harwell, Eng.). J. Phys., C, 1: 333-46(Apr. 1968). (AERE-R-5521).

The scattering of 5.4 Å neutrons by defects in single crystals of neutron-irradiated magnesium oxide was measured over the angular range 5 to 90°. The effects of irradiation dose and subsequent annealing treatments were studied in the range 5×10^{19} to 2.5×10^{21} neutrons cm^{-2} (>1 MeV) and 350 to 1460°C, respectively. The shapes of the curves of the observed cross section against angle were found to be sensitive to the annealing temperature, but were influenced only slightly by the irradiation dose. In all cases the cross section decreases with angle, this decrease becoming more pronounced the higher the annealing temperature. Evidence is pre-

sented which suggests that the defect scattering occurs predominantly from vacancies. The results were compared with the scattering expected from a number of vacancy aggregate models and correlations were obtained for aggregates containing between 1 and about 100 vacancies per cluster in the temperature range 150°C (during irradiation) to 1460°C. At the two extremities of this size range it is shown that the present conclusions are in reasonable agreement with the results obtained by other workers from electron spin resonance and electron microscope observations. After a 4-MeV electron irradiation at 500°C to a dose of 1.4×10^{19} electrons cm^{-2} no defect scattering could be observed within the accuracy of the cross-section measurements (±0.5 mbn sr^{-1} $molecule^{-1}$). (auth) (UK)

24475 EXPERIMENTAL AND THEORETICAL STUDY OF THE ABSORPTION OF ULTRA-SOFT X-RAYS IN PLATINUM AND TANTALUM. Jaegle, P. (Faculte des Sciences, Paris, Orsay, France); Farnoux, F. Combet; Dhez, P.; Cremonese, M.; Onori, G. Phys. Lett., 26A: 364-5(Mar. 11, 1968).

The photoionization cross sections of platinum and tantalum, determined experimentally using the Frascati synchrotron radiation in the region of soft x-rays, are compared with the values calculated using a free atom model with central potential. (auth)

24476 MOESSBAUER SIX-LINE SPECTRA POSITION ANALYSIS FOR ^{57}Fe IN METALLIC IRON. Zemcik, T. (Inst. of Metallurgy, Brno). Czech. J. Phys., 18: 551-66(1968).

The formulas for evaluating the parameters of magnetically split Moessbauer six-line spectra with quadrupole splitting from measured line positions are derived. Some special cases are considered and the suitability of the center of gravity rule for the shift determination as well as the case of the internal magnetic field measurement from the distance of the outermost lines of the Moessbauer sextet are discussed. From the measured spectra of metallic iron the ratio of magnitudes of the nuclear magnetic moments for ^{57}Fe $|\mu_1/\mu_0| = 1.701 \pm 0.008$ is derived by means of the proposed method. Further, the internal magnetic field intensity at the ^{57}Fe nucleus in metallic iron $H_i = (329.4 \pm 1.2)$ kOe and other quantities are determined. (auth)

24477 REMARK ON AN ANOMALY OF THE SPIN-WAVE SPECTRUM IN SPIRAL SPIN STRUCTURES. Kalva, Z. (Inst. of Solid State Physics, Prague); Morkowsk, J. Czech. J. Phys., 18: 546-50(1968).

It is shown that magnetic dipolar interaction gives rise to a discontinuity in the magnon dispersion relation for antiferromagnetic spiral spin structures. Some numerical results for the magnon energy in dysprosium are presented. (auth)

24478 ELECTRON ABSORPTION SPECTRA AND EPR SPECTRA OF IRRADIATED SODIUM–CALCIUM SILICATE GLASSES. Sidorov, T. A.; Tyul'kin, V. A. Izv. Sib. Otd. Akad. Nauk SSSR, Ser. Khim. Nauk, No. 9, 67-9(July 1967). (In Russian).

The electron absorption spectra and the EPR spectra of irradiated sodium–calcium silicate glasses were investigated. It was shown that in the glasses investigated the correlation between the EPR spectra and the electron absorption spectra, established earlier by the author in two-component alkali silicate glasses, was maintained. The 6200 Å band of the optical spectra and its corresponding α component of the EPR lines with $g = 2.01$ were associated with holes located on the terminal nonbridge atom of oxygen, in the vicinity of which there are no alkali metal ions. The 4400 Å band and its corresponding β component of the EPR lines with $g = 2.01$ caused holes located on the terminal nonbridge atom of oxygen, in the vicinity of which alkali metal ions develop. Centers connected with the calcium atoms were detected in the glasses investigated. (tr-auth)

24479 SLIP LINE PATTERN AND ACTIVE SLIP SYSTEMS OF TUNGSTEN AND MOLYBDENUM SINGLE CRYSTALS WEAKLY DEFORMED IN TENSION AT ROOM TEMPERATURE. Kaun, L.; Luft, A.; Richter, J.; Schulze, D. (Deutsche Akademie der Wissenschaften, Berlin. Institut fuer Metallphysik und Reinstmetalle, Dresden). Phys. Status Solidi, 26: 485-99(Apr. 1, 1968).

Electron zone-refined tungsten and molybdenum single crystals are deformed in tension at room temperature. The slip systems on the cylinder-shaped tensile specimens are determined using the light as well as the electron microscope. The slip line pattern depends sensitively on the orientation of the stress axis. Single slip on the crystals investigated is not observed. The slip occurs preferentially on planes of type {110}, but usually further slip planes of the ⟨111⟩ zone are also active. The slip band structure is discussed in terms of elementary slip processes. (auth)

24480 RADIATION HARDENING OF NEUTRON-IRRADIATED COPPER SINGLE CRYSTALS. I. EXPERIMENTAL RESULTS. Ruehle, M. (Max-Planck-Institut fuer Metallforschung, Stuttgart. Univ., Stuttgart). Phys. Status Solidi, 26: 661-70(Apr. 1, 1968).

The temperature and strain-rate dependence of the critical shear stress (CSS) of neutron-irradiated copper before and after annealing were measured between 4 and 500°K. Measurements of the CSS of neutron-irradiated gold are also reported. By means of electron microscopy the density and size distribution of observable defects in identically irradiated copper foils were counted. Since a fairly wide size distribution was found, the interpretation of the CSS measurements is not simple. (auth)

24481 RADIATION HARDENING OF NEUTRON-IRRADIATED COPPER SINGLE CRYSTALS. II. INTERPRETATION. Frank, W.; Ruehle, M.; Saxlova, M. (Max-Planck-Institut fuer Metallforschung, Stuttgart. Univ., Stuttgart). Phys. Status Solidi, 26: 671-80(Apr. 1, 1968).

It is shown that the vacancy-type Frank dislocation loops on {111} planes observed in neutron-irradiated copper by means of electron microscopy lead to a decrease in the mobility of glide dislocations during plastic deformation, which accounts quantitatively for the enhancement of the critical shear stress of copper single crystals caused by neutron irradiation. This follows from the analysis of measurements of the critical shear stress and of electron-microscopic determinations of the loop density in terms of a statistical theory of thermally activated dislocation motion over barriers of different heights. No adjustable parameters enter this analysis. (auth)

24482 APPLICATION OF STEREO ELECTRON MICROSCOPY TO ANOMALOUSLY WIDE IMAGES IN NEUTRON-IRRADIATED SILICON. Pankratz, J. M.; Rudee, M. L. (Rice Univ., Houston, Tex.). Phys. Status Solidi, 26: K97-8(Apr. 1, 1968).

Stereo electron microscopy was used to study the anomalously wide images (AWI) resulting from defects near the surface of neutron-irradiated silicon foils. It is shown that the AWI lie at the two extremes of the vertical distribution of defect images and can be useful in the determination of defect character. (A.G.W.)

24483 SELF-TRAPPED HOLES IN NEUTRON-IRRADIATED CaF_2 AND BaF_2 CRYSTALS. Kazumata, Y. (Japan Atomic Energy Research Inst., Tokyo). Phys. Status Solidi, 26: K119-22(Apr. 1, 1968).

Electron spin resonance measurements on self-trapped holes in neutron-irradiated CaF_2 and BaF_2 crystals were analyzed using a spin Hamiltonian. Hyperfine structure and g tensors were calculated from the experimental data. From these values, the s and p character of the hybridized atomic wave functions were estimated. It is concluded that the self-trapped hole in the BaF_2 is localized mostly on the F_2 molecule ion itself. The hole in the CaF_2 spends about 98% of the time on the F_2 molecule ion itself and 2% of the time on the two outside fluorine ions. (A.G.W.)

24484 COLOUR CENTRES IN NEUTRON-IRRADIATED CALCIUM OXIDE. Henderson, B. (Univ. of Keele, Eng.); King, R. D. Phys. Status Solidi, 26: K147-9(Apr. 1, 1968).

The optical absorption spectrum of neutron-irradiated calcium oxide is described. The lattice defects involved have not yet been identified, but by analogy with MgO it is supposed that F-aggregate centers are present. Stress-splitting studies suggest some properties typical of the M-like centers in MgO. (A.G.W.)

24485 GAMMA RADIATION EFFECTS ON ELECTRIC PROPERTIES OF GaAS OF p-TYPE. Brailovskii, E. Yu., Konozenko, I. D. (Inst. of Physics, Kiev). Ukr. Fiz. Zh., 12: 2069-71(Dec. 1967). (In Russian).

The effect of high-intensity currents of ^{60}Co γ quanta on the electroconductivity of single crystals of p-type Zn-alloyed GaAs was investigated. The $10 \times 2.5 \times 1.0$ mm cross-shaped samples were exposed at room temperature to doses of 5.6×10^7, 9.6×10^7, 3.0×10^8, and 1.0×10^9 R. Four groups of samples were prepared with the following concentrations of current-carrying holes: $(1\text{-}1.5) \times 10^{16}$, $(3\text{-}4) \times 10^{16}$, $(0.8\text{-}1.5) \times 10^{17}$, and 1.0×10^{18} per cc. After exposure to the γ-ray dose, the rate of decrease in the concentration of holes was measured at room temperature. It was found that the rate decreased with increasing irradiation dose, and increased with increasing irradiation dose, and increased with increasing initial concentration of holes. The first phenomenon appears to be due to radiation annealing; the second may be explained by assuming that the defects induced by the γ-quanta enter into some form of complexes with the added Zn-alloying mixture. (TTT)

24486 DIFFUZIYA MECHENYKH ATOMOV I PROVODIMOST' V IONNYKH PRISTALLAKH. (Diffusion of Labeled Atoms and Conductivity in Ionic Crystals). Murin, A. N.; Lur'e, B. G. Leningrad, Izdatel'stvo Leningradskogo Universiteta, 1967. 100p.

A brief review is given on the processes of ionic conductivity, diffusion (self- and thermal), migration of ions, electric conductivity, and effects of hydrostatic pressures in ionic crystals. Labeled atom methods and the influence of various factors on the mechanism of transfer processes are discussed in detail. 131 references are included. (R.V.J.)

24437 PRODUCTION AND STAGE-I RECOVERY OF ELECTRICAL RESISTIVITY IN ELECTRON-IRRADIATED NOBLE METALS. Wiffen, Frederick William. Evanston, Ill., Northwestern Univ., 1967. 128p.

Thesis.

The production of irradiation damage in small wire specimens by incident 2.0-MeV electrons near liquid helium temperature and the subsequent damage recovery on annealing to 70°K were studied in aluminum, copper, silver, and gold. Recovery was studied by isochronal annealing with points 0.5°K apart and with a holding time of 20 minutes at each temperature. The production and recovery of damage was followed by measuring changes in the resistivity of the specimens, all measurements being made at liquid helium temperatures. The measured rates of resistivity production during irradiation were in reasonable agreement with earlier work. The damage increase was linear with integrated electron dose within the limits of the experimental accuracy. Frenkel pair resistivities determined by comparison of measured and theoretically calculated production rates were in agreement with earlier values determined in this way but were lower than values predicted on the basis of measured vacancy resistivities. The stage-I recovery spectra of aluminum and copper were found to be closely similar to earlier work. In both metals the substructure through the I_D substage agreed with earlier work but the I_E substage did not show the previously reported detail. Silver was found to be remarkably similar to copper but with corresponding processes shifted to lower temperatures. The behavior of gold is much more complex with only two well-resolved recovery peaks occurring in stage I. A very important result of the present work has been the demonstration in copper and silver of a dependence of the amount of stage I recovery on the initial damage concentration. (Diss. Abstr.)

24488 STORED ENERGY IN IRRADIATED SODIUM CHLORIDE. Bunch, James Marion. Lincoln, Neb., Univ. of Nebraska, 1967. 142p.

Thesis.

A differential thermal analysis technique has been used to measure the stored energy in x- and γ-irradiated NaCl containing F-center concentrations as high as 1.8×10^{18} cm^{-3}, and relatively small concentrations of M, R, and higher aggregate centers. For nominally pure samples, the rate of release of stored energy as a function of sample temperature has peaks at 135, 250, and 350°C, which have been tentatively explained in terms of the transformations of various defects produced by the radiation. Below 170°C, the energy probably comes from the agglomeration of various defects produced with the F centers, along with defects associated with R and higher aggregate centers in heavily colored samples. From 170 to 290°C, most of the energy comes from recombination of electrons from F centers, with an additional small contribution from M-center electrons, and from the recombination of vacancies from both the F centers and R and higher aggregate centers with interstitial chlorine. Above 350°C, some of the energy apparently comes from vacancies associated with M centers, and the rest from the final annealing of the lattice disorder associated with F centers. In a calcium-doped sample, R and higher aggregate centers were not present and thus did not contribute; the processes associated with electron-hole recombination occurred below 200°C, while the vacancy annealing processes seemed to occur at roughly the same temperatures as in the pure sample. The total stored energy from x-irradiated pure samples was found to vary approximately linearly with the F-center concentration plus twice the M-center concentration, for F center concentrations between 3×10^{17} cm^{-3} and 13×10^{17} cm^{-3}. The energy per F center, assuming that each M center contributes twice as much energy as one F center, is 12.4 ± 0.3 eV. For F-center concentrations between 3×10^{17} cm^{-3} and 6×10^{17} cm^{-3}, the total energy agreed with that reported by Phelps, who used a differential heat of solution method. The total energy from samples which were γ-irradiated well beyond the saturation of the F-center concentration at 7×10^{17} cm^{-3} was about 20% larger than that from x-irradiated samples with identical F-center concentrations. Also it was observed that the scatter in the total energy values from the x-irradiated samples increased with sample coloration. These effects are attributed to energy contributed by R and higher aggregate centers, which were present in relatively larger concentrations in the more heavily x-irradiated samples and in the γ-irradiated sample. It is suggested that the appearance of these centers was partially suppressed in some of the samples, and in Phelps' samples, by the presence of impurities. This interpretation is consistent with the observation that the stored energy from the calcium-doped sample, in which the appearance of the R and higher aggregate bands was completely suppressed by the impurities, was near the extrapolation of the energy from less heavily colored samples. (Diss. Abstr.)

24489 MAGNETIC PROPERTIES OF RARE EARTH METALS AND ALLOYS. Burr, Charles Robert. Los Angeles, Univ. of California, 1967. 104p.

Thesis.

An erbium-doped magnesium single crystal has been investigated using X-band paramagnetic resonance techniques. The resonance was observed over the region 1.4 to 4.2°K and the principal values of the g tensor are $g_{\parallel} = 8.90 \pm 0.1$ and $g_{\perp} = 5.77 \pm 0.1$. The linewidth is anisotropic, varying linearly with temperature in the liquid helium range. Extrapolating the observed linewidths to T = 0 an isotropic "residual" width of 110 gauss was found. Calculations show that the ratio of temperature-dependent portions of the linewidth for parallel and perpendicular field directions is consistent with an isotropic conduction-electron-localized electron exchange interaction with a value of 0.0065 eV. Calculations of g values using a point charge approximation for the crystalline field show that agreement is achieved when the L = 2 term is screened approximately 50%. The magnetic susceptibilities of cerium and lanthanum metals have been measured from room temperature through the melting point. Cerium has a unique fusion behavior with a negative melting slope, attributed to a 4f–5d electronic promotion. It is demonstrated that this promotion in cerium does not occur and that the small change in the susceptibility at cerium's two high-temperature phase transformations can be attributed almost entirely to changes in the Pauli susceptibility. An estimate of this change of about 3% of the susceptibility at the melting point is found by comparison with the high-temperature susceptibility of lanthanum. (Disser. Abstr.)

24490 RADIATION DAMAGE STUDIES IN DEGENERATE Si IRRADIATED AT LOW TEMPERATURES. Sivo, Louis Lajos. Lafayette, Ind., Purdue Univ., 1967. 170p.

Thesis.

Pulled (Czochralski) and float-zone n-type (NC, NF) and p-type (PC, PF) degenerate Si samples were irradiated using 1-MeV electrons and studied by dc conductivity, δ, and Hall coefficient R_H measurements. The experiments clearly demonstrated the temperature, the charge state and the Fermi level dependence of the irradiation effects. In PC and PF the respective removal rates of (0.70 ± 0.20) cm^{-1} and (1.1 ± 0.5) cm^{-1} did not change appreciably for irradiation temperatures between 7 and 90°K. The first isochronal annealing stage in δ occurred over the temperature range 295 to 365°K independent of irradiation temperature. Very little damage was observed in either NC or NF for irradiations from 7 to 60°K (removal rate ≈0.02 cm^{-1}). Above ≈60°K the damage rate increased abruptly with temperature. Removal rates for irradiations around 90°K were (0.4 ± 0.2) cm^{-1} and (0.9 ± 0.3) cm^{-1} for NC and NF, respectively. Isochronal heating up to 360°K showed no recovery for irradiations below 110°K. After producing damage in n-type Si using 1-MeV electrons from 70 to 140°K, radiation-induced recovery of δ and R_H could take place upon further irradiation with 350-keV electrons. Under certain conditions 1-MeV bombardment also showed the effect. Both NC and NF crystals exhibited the phenomenon, though they differed in many important respects. Studies of radiation-induced recovery indicated a threshold temperature associated with the effect such that annealing was very low for $T > T_{th}$ and quite high and ≈ constant for $T < T_{th}$. T_{th} was about 60°K in NF and 115°K in NC. The total amount of recovery depended upon the ambient temperature of the high-energy beam and on the samples. Radiation-annealing curves of δ vs flux (350 keV), for a given temperature, could be fitted by the superposition of two exponentials. Several possible models of defect production and radiation annealing are examined. (TSS) (Disser. Abstr.)

24491 RADIATSIONNAYA FIZIKA NEMETALLICHESKIKH KRISTALLOV. (Radiation Physics of Nonmetallic Crystals). Konozenko, I. D. (ed.). Kiev, Izdatel'stvo Naukova Dumka, 1967. 452p.

Reports presented at the joint conference of the USSR Academy of Sciences, UkrSSR Academy of Sciences, and USSR AEC (Kiev, Sept. 1965) cover the subjects on radiations effects on nonmetallic crystals, on various instruments and devices, and on production of radiation-resistant materials and devices. The papers are divided into the following groups: (1) general problems in radiation physics; (2) radiation effects on diamond lattice crystals; (3) radiation effects on semiconductors; (4) radiation effects on alkali metal halide compounds; (5) radiation effects on solids; and (6) radiation effects on instrumentation. (R.V.J.)

24492 THERMAL-NEUTRON-INDUCED-DEFECTS IN CADMIUM TELLURIDE AND CADMIUM SULFIDE. Barnes, Charles Edward. Ann Arbor, Mich., Univ. of Michigan, 1967. 147p. Thesis.

The objective of this investigation was to clarify further the (n,γ) recoil-defect production in CdTe and CdS by measuring changes in Hall effect, electrical conductivity, and luminescence before and after successive thermal neutron irradiations. CdTe and CdS were chosen for study because of the large capture cross section of cadmium. In addition, radiative capture in cadmium does not lead to transmutation doping since ^{114}Cd is a stable nucleus. The Hall effect of n- and p-type CdTe and CdS was measured from 4 to 300°K after each irradiation. From this data information on the energy levels and carrier removal rates occurring in these materials is obtained. Luminescence measurements were carried out at 9°K over the wavelength range 4700 Å to 2.6 microns to ascertain the effect of thermal-neutron-induced defects on the emission bands in CdTe and CdS. A detailed examination of the thermal-neutron-induced recoil process reveals that only the first one or two gamma rays emitted contribute significantly to the recoil momentum of the ^{114}Cd nucleus. Hence, the majority of recoil events produce only one displacement, the ^{114}Cd nucleus itself. Te (or S) displacements are produced only by those occasional recoil events in which an initial high-energy gamma ray is emitted. The experimental evidence obtained in this investigation corroborates this picture of the recoil process. Electrical measurements reveal that the Hall coefficient and resistivity of n- and p-type CdTe and CdS increase with irradiation over the entire temperature range. Analysis of these results indicates that, during the irradiation of CdTe, approximately one Cd_v (cadmium vacancy) and one Cd_i (cadmium interstitial) are introduced per absorption event while Te defects are produced at a much slower rate. Annealing of these defects occurs during irradiation but not at room temperature after irradiation. The defects anneal out between 160 and 200°C. Electron removal in CdS as a function of the number of absorptions is also explained by the presence of isolated cadmium vacancies. However, it must be assumed that a large excess of Cd defects were present before irradiation. This agrees with the well-known fact that CdS is difficult to produce in exactly stoichiometric proportions. Luminescence measurements on CdTe show that thermal neutron irradiation causes a decrease in emission intensity over the entire wavelength range. By a comparison with CdS, the changes in edge emission are explained by identifying the Te interstitials as the edge emission center. In accordance with Hall measurements on p-type CdTe, the identification of a bound exciton emission band leads to an assignment of an energy level at $E_v + 0.20$ eV for the cadmium vacancy. (Disser. Abstr.)

24493 INFLUENCE OF ^{60}Co GAMMA IRRADIATION ON THE BULK AND SURFACE RECOMBINATION RATES IN SILICON. Littlejohn, Michael Anthony. Raleigh, N. C., North Carolina State of the Univ. of North Carolina, 1967. 228p. Thesis.

The technique of photoconductive decay in rectangular semiconductor filaments was used to measure the bulk and surface lifetimes and surface recombination velocity of 100 ohm-cm n- and p-type float zone refined silicon doped with phosphorous and boron, respectively. The influence of ^{60}Co gamma radiation on these important material parameters was investigated, and a more complete mathematical model for surface recombination velocity was formulated. This model includes the effects of recombination in the space charge region near the surface, and it is shown that this effect can have a significant contribution to the total surface recombination velocity. The recombination center which dominates the bulk lifetime in n-type material was found to be different from the one which controls the lifetime in p-type material. In n-type material the recombination center created by gamma radiation was found to be located at 0.40 eV below the conduction band edge, and is associated with a phosphorous-vacancy complex in the crystal. In p-type material, the center was located at 0.18 eV above valence band edge. It is believed that this is the first time such a recombination center has been observed in p-type float-zone-refined material. Irradiation by gamma rays had a drastic effect on the surface recombination velocity in n-type silicon, while in p-type silicon there was only a slight variation of this parameter with radiation. In n-type material the surface recombination velocity exhibited a relative minima with gamma-ray exposure. In p-type material there was a slow monotonic increase in the surface recombination velocity as each sample was irradiated. The surface lifetime obeyed the one level Shockley–Read equation for the lifetime. No single energy level could be located at the surface since the position of this level changed with each additional exposure to gamma radiation. This behavior cannot be explained with the data and models used in these experiments. (Disser. Abstr.)

Theoretical Physics

24494 COMPLEMENTARY VARIATIONAL PRINCIPLES IN PERTURBATION THEORY. Arthurs, A. M.; Robinson, P. D. (Univ. of York, Eng.). Proc. Roy. Soc. (London), Ser. A, 303: 503-9(Mar. 19, 1968).

Complementary upper and lower bounds are derived for second-order quantum-mechanical perturbation energies. The upper bound is equivalent to that of Hylleraas. The lower bound appears to be new, but reduces to that of Prager and Hirschfelder if a certain constraint is applied. A simple application to a perturbed harmonic oscillator is presented. (auth) (UK)

24495 ANALYSIS OF MEASUREMENT IN MACRO- AND MICROPHYSICS. Chylinski, Zygmunt (Inst. of Nuclear Research, Krakow). Nukleonika, 13: 23-8(1968).

The measuring processes which determine the sizes of physical objects are analyzed. On this basis two types of the space intervals are introduced which correspond to space extensions of physical entities in macro and in microphysics. (auth)

24496 MOMENTUM DISTRIBUTION IN THE TOMONAGA MODEL. Gutfreund, H.; Schick, M. (Stanford Univ., Calif.). Phys. Rev., 168: 418-25(Apr. 10, 1968).

The momentum distribution function for the ground state of the one-dimensional Tomonaga model at $T = 0$ is derived. The applicability of the model is discussed. It is found that the restriction on the strength of the interaction is actually much weaker than that suggested by Tomonaga. The behavior of the distribution function near the Fermi momentum is investigated. (auth)

24497 THEORY OF CHARGED PARTICLE MOTION IN CONSTANT-DIRECTION AND EXPONENTIALLY TIME-DEPENDENT MAGNETIC FIELDS. I. GENERAL THEORY AND INTERPOLATION PROCEDURE. Koch, Eckhard (Arbeitsstelle fuer Statistische, Leipzig). Beitr. Plasmaphys., 7: 479-99(1967). (In German).

The general solution of the equations of motion for a charged particle in a magnetic field is given for the following case: the spatially homogeneous magnetic field having a constant direction is a superposition of a field constant in time and one decreasing exponentially in time: taken into account is the influence of the electric field induced by the time-dependent magnetic field and a friction force proportional to the particle velocity. The higher transcendental functions appearing in the exact solution are approximated in various ways in dependence on the values of the argument and parameters. The important case of a switching process without a friction force is investigated in detail. The higher transcendential functions can be approximated by simpler functions in such a way, that the solutions for the switching process, valid for all times, differ from the solutions in the case of a linear increasing magnetic field only by factors consisting of elementary functions. Approximated formulae of a very simple form are obtained for position, velocity, kinetic energy and magnetic moment of the particle. The particle orbits are classified and their dependence on the initial values and parameters of the magnetic fields is studied. A comparison between the results and a rectangular variation of the field shows that the latter is not a good approximation for a really exponential increasing field. Finally, a detailed investigation shows that the electric field induced by the time-dependent magnetic field has an important influence on the particle motion. (auth)

24498 NUMERICAL SOLUTION OF THE S-LIMIT SCHROEDINGER EQUATION. Winter, N. W.; Diestler, Dennis; McKoy, Vincent (California Inst. of Tech., Pasadena). J. Chem. Phys., 48: 1879-82(Mar. 1, 1968).

Numerical solutions to the S-limit Schrödinger equation have been obtained for He and Li^+. Using these the energy and the expectation values $\langle r_1 \rangle$ and $\langle r_1^2 \rangle$ were calculated and compared to the radial configuration interaction values. The results demonstrate that the direct numerical solution of many partial differential equations in chemical physics can be accomplished in a practical and straightforward manner. (auth)

24499 PHASE AND ANGLE VARIABLES IN QUANTUM MECHANICS. Carruthers, P. (Cornell Univ., Itaca, N. Y.); Nieto, Michael Martin. (Contract AT(30-1)-3699. Rev. Mod. Phys., 40: 411(Apr. 1968). (NYO-3699-18).

The proper description of phase and angle variables in quantum mechanics is treated. The discussion begins from the viewpoint of the Heisenberg uncertainty relations and reviews methods for obtaining minimum uncertainty states. Obtaining the position momentum, minimum uncertainty, "coherent" states is a first example of the use of these methods. The first angle variables considered are angular momentum angle. By using periodic angle variables, much insight into the correct nature of "phase" variables is obtained.

This also allows a thorough discussion of this problem. The development then turns to the number-phase variables of the harmonic oscillator. After showing the invalidity of a unique "Hermitian" phase operator, the correct periodic phase operators are obtained. The properties of these operators, their states, and their associated uncertainty relations are all investigated. A similar discussion ensues for the very important phase difference operators. The above concepts are then extended to statistical mechanics in the coherent state basis. Emphasis is on action-angle variables, irreversibility, and the uncertainty relation between the angle variable and the Liouville operator. Mention is made of possible physical applications to superfluid-type systems. (auth)

24500 MOTION OF CHARGED PARTICLES IN A MAGNETIC FIELD REVERSAL ZONE. Anderson, N. (Univ. of York, Eng.). Int. J. Electron., 23: 263-5(1968).

The motion of a charged particle in a region of space where a steady magnetic field reverses its direction is considered. (auth)

24501 GREEN'S FUNCTIONS. Stedman, G. E. (London Univ.). Contemp. Phys., 9: 49-69(Jan. 1968).

The motivation for the use of the Green's function (GF) concept in mathematical physics, and the diversity of its applications are discussed, with reference to both classical and quantum mechanical problems. First, the impulse response GF is defined and its use is demonstrated in a problem in electrostatics. The connection with the wave response GF is explained and illustrated in an electronics problem. After a review of the use of these concepts in classical problems, their unification in quantum mechanics is discussed. An outline of the ideas of quantum field theory prefaces a discussion of the application of GFs to quantum mechanical problems, especially in many-body theory. The two most important mathematical techniques used in the evaluation of GFs are compared. (auth) (UK)

24502 RADIATION-INDUCED SPIN POLARIZATION OF ELECTRONS MOVING IN A SPIRAL ORBIT IN A MAGNETIC FIELD. Sokolov, A. A.; Ternov, I. M.; Bagrov, V. G.; Galzov, D. V.; Shukovskii, V. T. (Moscow State Univ.). Z. Phys., 211: 1-8(Mar. 12, 1968). (In German).

Spontaneous radiation-induced spin-polarization effects on electrons moving in a spiral orbit in a magnetic field are investigated. Various methods for describing the electron spin states are discussed. (auth)

24503 CLASSICAL MOTION OF AN ELECTRON IN AN ELASTIC-DIPOLE FIELD. I. FINITE DIPOLE CASE. Turner, J. E.; Fox, K. (Oak Ridge National Lab., Tenn.). J. Phys., A, 1: 118-23(Jan. 1968).

The classical motion of an electron in the field of a finite electric dipole is analyzed in terms of Hamilton–Jacobi theory. It is shown that a bound state exists for an arbitrarily small dipole moment. (auth) (UK)

24504 CLASSICAL MOTION OF AN ELECTRON IN AN ELECTRIC-DIPOLE FIELD. II. POINT DIPOLE CASE. Fox, K. (Univ. of Tennessee, Knoxville, Oak Ridge National Lab., Tenn.). J. Phys., A, 1: 124-7(Jan. 1968).

The classical motion of an electron in the field of a point electric dipole is analyzed. It is shown that the only motion for which the distance r from the dipole to the electron does not either increase without limit or decrease to and remain at zero is that for which r is constant and the total energy E is zero. A necessary condition for such bound motion is $D > 3\sqrt{3}p\phi^2/4me$, where D is the dipole moment, $p\phi$ is the component of angular momentum along the dipole axis, and m and e are the electronic mass and charge. It follows that any point dipole can bind an electron classically. (auth) (UK)

24505 THEORY OF MIXED FERMI–BOSE SYSTEMS WITH ARBITRARY NUMBERS OF INTERACTING SPECIES. Etters, R. D. (Douglas Advanced Research Labs., Huntington Beach, Calif.); Raich, J. C. Nuovo Cim., 54B: 304-18(Apr. 11, 1968).

A dynamical theory that describes the low-temperature behavior of systems containing an arbitrary number of different interacting Bose and/or Fermi species is developed. The governing equations of motion are solved in an approximate way and then used to obtain a dispersion relation for the eigenfrequencies of the low-lying states of the system. The appropriate double time-temperature Green functions are determined and used to obtain various correlation functions. Also, the probability per unit time $P(k,\omega_k)$ that a particle transfers momentum k and energy ω_k to the multi-species system by scattering is calculated. (auth)

24506 NOTE ON MEASUREMENT. Earman, J. (Princeton Univ., N. J.); Shimony, A. Nuovo Cim., 54B: 332-4(Apr. 11, 1968).

A theorem proved by Wigner, who considered an idealized process of measurement upon an object the states of which are represented (in a one–many mapping) by vectors of a Hilbert space, is generalized. In this generalization the degeneracy of the eigenvalues of the operator L on the Hilbert space is allowed by permitting $L\sigma^{\nu m} = \lambda_\nu \sigma^{\nu m}$, where $\lambda_\nu \neq \lambda_\mu$ if $\nu \neq \mu$ and the $\sigma^{\nu m}$ are orthonormal vectors spanning the Hilbert space and by admitting final states of object-plus-apparatus which are simply direct products. (J.F.P.)

24507 ORTHOGONALITY CONDITION FOR THE EXCITED STATES OF STATIONARY QUANTUM SYSTEMS. Sharma, C. S. (London Univ.). Can. J. Phys., 46: 43-7(Jan. 1, 1968).

A theorem establishing the correct orthogonality condition for the perturbation expansions of the state vectors for the excited states of stationary quantum systems is enunciated. A common misunderstanding on this subject is discussed and corrected. Implications of the theorem to the use of the variation perturbation method for calculating approximate eigenvalues and eigenvectors for excited states is discussed. (auth)

24508 APPROXIMATE CALCULATION OF THE NON-ADIABATIC MOTION OF A CHARGED PARTICLE IN AN INHOMOGENEOUS ROTATIONALLY SYMMETRIC MAGNETIC FIELD. Kranys, M. (Inst. of Plasma Physics, Prague). Czech. J. Phys., 18: 504-16(1968).

A study is made of the motion of a particle injected longitudinally into a rotationally symmetric magnetic field increasing linearly in an arbitrarily sharp way on the axis of symmetry. By expanding the magnetic potential in a series in the vicinity of the line of force from which the particle starts, and by restricting our considerations to linear terms, a single linearized equation of motion for the radial motion is obtained, as one assumes the longitudinal motion to be uniform. The linearized equation can be solved exactly. Numerical evaluation is carried out (with the linearized line of force) for several different slopes of the field, and compared for similar cases with a numerical evaluation of an exact nonlinear problem. The method described can also be applied to cases with more general initial conditions, when the particle also moves with an azimuthal velocity. (auth)

24509 THEORY OF PARTICLE MOTION IN TIME-DEPENDENT ELECTROMAGNETIC FIELDS. Vojta, Guenter; Wonn, Joachim (Deutsche Akademie der Wissenschaften, Berlin). Beitr. Plasmaphys., 7: 501-6(1967). (In German).

The Langevin equation of motion for a charged particle including a collision term proportional to the particle velocity is solved for arbitrary time-dependent electric and magnetic fields by a new general method. Instead of the usual ansatz: particle velocity = cyclotron velocity + drift velocity, the method given makes the ansatz: particle velocity = tensor · cyclotron velocity. The unknown tensor obeys a simple differential equation of the first order which can be generally solved at once. This method is a modification of the variation of constants method for inhomogeneous differential equations. The electromagnetic fields considered must be spatially homogeneous; for (weakly) inhomogeneous fields an iteration procedure of Pytte (1962) may be applied. Some examples are discussed shortly. The Langevin equation treated is completely equivalent to the equation of motion in a magnetohydrodynamic one-fluid theory. (auth)

24510 METHOD FOR SOLVING THE NONSTATIONARY TRANSPORT EQUATION. Boyarintsev, Yu. E.; Uznadze, O. P. Zh. Vychisl. Mat. i Mat. Fiz., 7: 1406-13(Nov.-Dec. 1967). (In Russian).

The method of spherical harmonics is widely used for the solution of the transport equation, formulating the boundary conditions with respect to the coefficients. The boundary problem may be solved by the differential method and by matrix factorialization for a one-dimensional geometry but it is difficult to apply for the multidimensional case. Therefore, the method was supplemented for multidimensional cases by the fission method, examining the properties of the single-velocity kinetic equation of a finite cylinder; it was assumed that the properties of the medium do not depend on the azimuthal angle. The new program developed introduces a considerable economy in the working memory. The convergence was tested on the basis of G. I. Marchuk's approximation. The method covers cases involving infinite cylinders and spheres and may be used for solving multigroup and stationary equations. (TTT)

24511 RANDOM MATRICES AND THE STATISTICAL THEORY OF ENERGY LEVELS. Mehta, M. L. New York, Academic Press Inc., 1967. 267p. $12.00; 96s.

This volume develops a coherent and detailed treatment of random matrices as applied to the study of nuclear and atomic spectra. Given the distribution of matrix elements satisfying certain symmetry conditions, the problem is to find the distribu-

tion of quantities depending on a few eigenvalues. This technique provides an analytic treatment of spectra otherwise too complex to explain. (W.D.M.)

24512 EINFUEHRUNG IN DIE QUANTENTHEORIE. (Introduction to the Quantum Theory). Schneider, Franz. New York, Springer-Verlag, 1967. 226p.

Experiments in which the contrast between quantum theory and classical physics is clearly shown are described. A preliminary introduction for the quantizing of a system in the Schroedinger description is given in the form of axiomatic postulates and explained on the basis of examples in the differential representation. The conventional theory of the hydrogen atom is outlined. The mathematical formalisms are then constructed. In the quantizing of the harmonic oscillator, the differential and matrix representations are compared with each other and the operator equations were introduced. Formalisms of the nonrelativistic theory are constructed. A brief introduction is also presented of relativistic quantum mechanics and quantum field theory. (J.S.R.)

PHYSICS (HIGH ENERGY)

Particle Interactions and Properties (Experimental)

Refer to abstracts 24567, 24570, and 24748.

Electromagnetic

Refer also to abstract 24078.

24513 (INSJ–107) PHOTOPRODUCTION OF N*(1236) FROM HYDROGEN. Ukai, K.; Takamatsu, K.; Murata, Y.; Mori, K.; Mishina, M.; Matsumoto, S.; Kusumegi, A. (Tokyo Univ. (Japan). Inst. for Nuclear Study). Dec. 25, 1967. 39p. Dep.

Measurements were made on the production of N*(1236) through the reaction $\gamma + p \rightarrow \pi^- + \pi^+ + p$ by detecting one pion pair and a proton in coincidence. The kinematical condition was chosen in such a way that the invariant mass of the detected pion and proton was in the range of the first pion-nucleon resonance. The experimental results show that the reaction $\gamma + p \rightarrow \pi^- + \pi^+ + p$ proceeds mainly through the 3-3 isobaric state N^{*++}. A direct comparison is given of the yield of N^{*++} with that of the rest of the channels for the present experimental condition. (auth)

24514 (LAL–1186) POSITIVE PION PHOTOPRODUCTION FROM HYDROGEN FOR INCIDENT PHOTON ENERGIES 300–750 MeV. Betourne, C.; Bizot, J. C.; Perez-Y-Jorba, J.; Treille, D. (Paris Univ., Orsay (France). Laboratoire de l'Accelerateur Lineaire); Schmidt, W. (Stanford Linear Accelerator Center, Calif.). Feb. 1968. 47p. Dep.

The differential cross section for the reaction $\gamma + p \rightarrow \pi^+ + n$ was measured at 19 photon energies, between 300 and 750 MeV in the laboratory, for pion angles between 0 and 130° in the cms system. The pions were analyzed in angle and momentum with a magnetic spectrometer and detected by a counter telescope. The 0° measurements could be achieved, in spite of the excessive positron rate, owing to a mass spectrometer arrangement. No direct indication for the electromagnetic excitation of the P_{11}- resonance (1466 MeV) was found. Comparison is made with theoretical calculations of π^+ photoproduction. (auth)

24515 EXPERIMENTAL LIMIT ON φ-MESON PHOTOPRODUCTION FROM HYDROGEN AT 15 GeV. Boyarski, A.; Bulos, F.; Busza, W.; Diebold, R.; Ecklund, S.; Fischer, G.; Richter, B. (Stanford Univ., Calif.). Phys. Rev. Lett., 20: 877-8(Apr. 15, 1968).

The momentum dependence of the π^- and K^- fluxes produced by a bremsstrahlung beam in a hydrogen target is examined. The differences of 1.45° yields obtained from hydrogen with bremsstrahlung beams of end-point energies 14 and 16 GeV are shown. The π^- yield expected from $\gamma + p \rightarrow \rho^0 + p$ interactions and the K^- yield expected from the $\gamma + p \rightarrow \phi + p$ interactions are shown. (J.F.P.)

24516 SINGLE SCATTERING OF 5 GeV/c MUONS IN NUCLEAR EMULSION. McNulty, P. J. (Clarkson Coll. of Tech., Potsdam, N. Y. State Univ. of New York, Buffalo); Breault, R. O.; Jain, P. L. Nucl. Phys., B5: 181-7(1968).

The single-scattering distribution of 5 GeV/c muons was measured in nuclear emulsion. The muon tracks were followed by fast-scanning technique and thus a total of 312 single-scattering events of angle ≈1.4 mrad was found from 40.9 m track length. Pion contamination in the muon beam was negligible. The observed scattering distribution which extends up to 0.5° scattering angle is in good agreement with the electromagnetic theory. (auth)

24517 CORRECTIONS TO THE EXPERIMENTAL VALUE FOR THE ELECTRON g-FACTOR ANOMALY. Rich, Arthur (Univ. of Michigan, Ann Arbor). Phys. Rev. Lett., 20: 967-71(Apr. 22, 1968).

A recalculation of the g-factor anomaly of the free electron, based on the data of Wilkinson and Crane, results in the value $a = 0.001,159,557 \pm 30 \times 10^{-9}$. This is lower than theoretical estimates by more than the quoted experimental error. (auth)

24518 PROTON PROTON BREMSSTRAHLUNG AT 10.5 MeV. Crawley, G. M.; Powell, D. L.; Rao, B. V. Narasimha (Australian National Univ., Canberra). Phys. Lett., 26B: 576-8(Apr. 1, 1968).

The proton proton bremsstrahlung cross section was measured at an incident proton energy of 10.5 MeV. The upper limit of 1.3 $\mu b/sr^2$ helps to distinguish between the various calculations at this energy. (auth)

24519 PROTON PROTON BREMSSTRAHLUNG AT 20 MeV. Bahnsen, A.; Burman, R. L. (Univ. of Rochester, N. Y.). Phys. Lett., 26B: 585-7(Apr. 1, 1968).

The proton proton bremsstrahlung was investigated at 20 MeV beam energy. The outgoing protons were detected at equal angles of 35° to the beam, and the cross section $d^3\sigma/d\Omega_1 d\Omega_2$ was found to be 1.3 ± 0.4 $\mu b/sr^2$. This value is in agreement with theoretical calculations, and with other experimental data at low energies. (auth)

24520 PHOTODISINTEGRATION OF THE DEUTERON FROM 140 TO 400 MeV. Buon, J.; Gracco, V.; Lefrancois, J.; Lehmann, P.; Merkel, B.; Roy, Ph. (Ecole Normale Superieure, Orsay, France). Phys. Lett., 26B: 595-7(Apr. 1, 1968).

The angular distributions for deuteron photodisintegration were measured in the energy region 140 to 400 MeV for recoil protons laboratory angles between 30° and 130°. The protons were analyzed in momentum with a magnetic spectrometer and detected by a counter hodoscope. (auth)

24521 SINGLE-POSITIVE-PION PHOTOPRODUCTION ON HYDROGEN IN THE ENERGY RANGE (500 TO 800) MeV. Beneventano, M. (Univ., Rome. Istituto Nazionale di Fisica Nucleare, Rome); Paoluzi, L.; Sebastiani, F.; Severi, M.; Grilli, M. Nuovo Cim., 54A: 468-74(Mar. 21, 1968). (NP–17262).

Cross sections for the photoproduction of positive pions in hydrogen were measured at the 1.1 GeV Frascati electron synchrotron for photon energies E_γ between 500 and 800 MeV and for π^+ c.m. angles of $\theta = 30°, 90°$. The cross sections exhibit a smooth behavior as a function of energy for E_γ = (500 to 600) MeV. No immediate evidence is found of a contribution of the P_{11} resonance. (auth)

24522 MEASUREMENT OF THE PION FORM FACTOR BY COINCIDENCE ELECTROPRODUCTION. Ash, WilliamWesley. Ithaca, N. Y., Cornell Univ., 1967. 147p.

Thesis.

Using the internal circulating beam of the Cornell 2.2 GeV electron synchrotron and a liquid hydrogen target, the reactions of pion electroproduction, $e + p \rightarrow e + p + \pi^0$ and $e + p \rightarrow e + n + \pi^+$ were studied. Using two quadrupole magnets with counter telescopes the final electron and charged nucleon/pion were momentum analysed and detected in coincidence. Accurate measurements of the cross section were made at pion-nucleon center of mass angles of 0° and 180°, c.m. energies of 1175, 1200, and 1300 MeV, and four momentum transfers of 1, 3, 1, and 8 F^{-2}. The effects of the longitudinal component of virtual photon polarization were experimentally isolated as well. The neutral pion data were used as an overall check on the adequacy of present electroproduction theory as given by Zagury using dispersion relations. The charged pion data were fitted to theory using the only adjustable parameter available, the pion form factor. The pion form factor agrees best with nucleon form factor behavior, but is not in unreasonable disagreement with that predicted by rho exchange. The extracted rms radius of the pion is found to be .75 ± .1 Fermis. (Disser. Abstr.)

24523 POLARIZATION OF RECOIL PROTONS FROM THE PHOTOPRODUCTION OF NEUTRAL PIONS IN HYDROGEN BETWEEN 750 AND 1450 MeV. Bloom, Elliott Daniel. Pasadena, Calif., California Inst. of Tech., 1967. 130p.

Thesis.

In a recent experiment on π^0 photoproduction 1.5 BeV electron synchrotron, the polarization of the recoil proton was measured. The measurement was performed using a scattering and range spark chamber built out of variable thickness carbon modules. The sample of π^0's was pure to better than 98%. Approximately 3500 useful scatters were obtained to yield polarization values, around 60° c.m. for the produced pion, for incoming photon energies $750 \leq k \leq 1450$ MeV. The polarization values were obtained with a maximum likelihood method. A thorough investigation was made of all analyzing power data available for proton carbon scattering. The results indicate a striking angular dependence, with the polarization changing sign for $\theta^*_\pi \sim 60°$ to 70° throughout the energy region covered. These results are interpreted in the framework of an isobar model of π^* photoproduction with Regge-ized ω exchange amplitude added. (Disser. Abstr.)

Weak

24524 (BNL–10312) DECAY AND COHERENT REGENERATION OF NEUTRAL K-MESONS IN LIQUID HYDROGEN. Bacon,

T. C.; Eisler, F. R.; Hopkins, H. W. K. (Brookhaven National Lab., Upton, N. Y.). June 2, 1966. Contract AT(30-2)-Gen-16. 13p. Dep. CFSTI.

A study of K^0 decays along a long-lived K^0 beam propagating in a liquid hydrogen bubble chamber is reported. The studied beam had a broad momentum spectrum extending from 0.4 to 4.0 GeV/c. The study of 21,000 V decays leads to the following conclusions: The data are consistent with the hypothesis that all the observed $\pi^+ + \pi^-$ decays along the K_L^0 beam can be accounted for by the processes of $K_L^0 \rightarrow \pi^+ + \pi^-$ decay and coherent K_S^0 regeneration in liquid hydrogen. In the momentum range 0.4 to 1.6 GeV/c the $K^0 \rightarrow \pi^+ + \pi^-$ decays observed along the K_L^0 beam can be completely accounted for by the processes of $K_L^0 \rightarrow \pi^+ + \pi^-$ decay and coherent short-lived K^0, K_S^0 regeneration in liquid hydrogen, and no evidence of the anomalous regeneration previously proposed is found. In the momentum range 1.6 to 4.0 GeV/c a factor of three times the $K^0 \rightarrow \pi^+ + \pi^-$ decays along the K_L^0 beam than expected from $K_L^0 \rightarrow \pi^+ + \pi^-$ and coherent K_S^0 regeneration. However, this result is only 1.9 standard deviations from the expected rate and could be only the effect of statistical fluctuations. (J.F.P.)

24525 MEASUREMENT OF THE TOTAL MUON POLARIZATION IN $K^+ \rightarrow \pi^0 + \mu^+ + \nu$. Cutts, D. (Univ. of California, Berkeley); Stiening, R.; Wiegand, C.; Deutsch, M. Phys. Rev. Lett., 20: 955-8(Apr. 22, 1968).

From a measurement of the total polarization of the muon, the parameter $\xi(q^2)$ in the decay $K^+ \rightarrow \pi^0 + \mu^+ + \nu$ was determined. (auth)

24526 DETERMINATION OF THE BINDING-ENERGY VALUES OF LIGHT HYPERNUCLEI. Bohm, G. (Forschungsstelle fuer Physik Hoher Energie, Berlin); Klabuhn, J.; Krecker, U.; (and others). Nucl. Phys., B4: 511-26(1968).

The results of an experimental study of the binding energies of light hypernuclei are presented, based on a sample of 2008 uniquely identified π^- mesonic decays. The problems of the calibration procedure and the selection criteria are discussed. Various aspects of the Λ-N interaction are reviewed in the light of these new results. (auth)

24527 QUESTION OF THE EXISTENCE OF A PARTICLE-STABLE $^6_\Lambda$Li HYPERNUCLEUS. Coremans, G. (Univ. Libre, Brussels); Gajewski, W.; Mayeur, C.; Sacton, J.; Vilain, P.; Wilquet, G.; Davis, D. H.; Wickens, J. H. Nucl. Phys., B4: 580-4(1968).

The recently reported evidence for the existence of the $^6_\Lambda$Li hypernucleus is questioned. No sample of the ($\pi^-{}^1H^1H^4He$) decay mode of this hypernucleus was found in a sample of 7000 mesonically decaying hypernuclei. (auth)

24528 A MEASUREMENT OF THE $\pi^+ \rightarrow \pi^0 + e^+ + \nu$ DECAY RATE. Depommier, P.; Duclos, J.; Heintze, J.; Kleinknecht, K.; Rieseberg, H.; Soergel, V. (CERN, Geneva). Nucl. Phys., B4: 189-225(1968).

The rate of the decay $\pi^+ \rightarrow \pi^0 + e^+ + \nu$, the beta decay of the π^+, was measured by means of a counter scheme, in which this process is detected with an efficiency of 22.4 ± 0.8%. For 1.48×10^{11} π^+ coming to rest in the apparatus, 332 ± 10 pion beta decays were observed. This leads to a branching ratio $R[(\pi^+ \rightarrow \pi^0 + e^+ + \nu / \pi^+ \rightarrow \mu^+ + \nu)] = (1.00^{+0.09}_{-0.10}) \times 10^{-8}$, corresponding to a decay rate $\lambda_{\pi^+\pi^0} = (0.38^{+0.03}_{-0.04})$ sec^{-1} in good agreement with the prediction of the CVC theory, $\lambda_{\pi^+\pi^0}$ (CVC) = (0.393 ± 0.002) sec^{-1}. (auth)

24529 FINAL STATE INTERACTION EFFECTS IN π^- MESONIC DECAYS OF LIGHT HYPERNUCLEI. Harmsen, D. M. (Univ. of Chicago); Levi Setti, R.; Zakrzewski, J.; (and others). Nucl. Phys., B4: 277-94(1968).

The results of a search for final-state interactions between the decay products of some light hypernuclei ($3 \leq A \leq 12$) are presented. (auth)

24530 K^+ THREE-BODY LEPTONIC DECAY MODES. Marateck, Samuel Leslie. New Brunswick, N. J., Rutgers-The State Univ., 1967. 61p.

Thesis.

From an exposure of K^+ stoppings in the Brookhaven 30 in. propane chamber, the K_{e3} and $K_{\mu 3}$ Dalitz plots for lepton momenta below 120 MeV/c were studied. $K_{\mu 3}$ decays were separated from K_{e3} decays by physicists examining the lepton's ionization, radiation loss and range. The lepton momentum is measured directly and the π^0 momentum is obtained by measuring its decay gamma ray directions and the conversion electron-positron pair momenta. The π^0 momentum error is typically 5%. Because of this resolution, the $K_{\mu 3}$ and τ' modes can be separated and thus the $K_{\mu 3}$ Dalitz plot below 120 MeV/c is free of τ' background. The vector interaction for both K_{e3} and $K_{\mu 3}$ decays is verified and the analysis of form factors for 78 $K_{\mu 3}$ events yields, assuming no energy dependence, $\mathrm{Re}\xi = -0.5 \pm 0.9$ and $|\mathrm{Im}\xi| = 0.0^{+3.5}_{-3.0}$ and a discrimination of 150/1 against a second value of $\mathrm{Re}\xi = \pm^{1.0}_{0.5}$. Analysis of the K_{e3} form factor, f^+, for 90 K_{e3} events shows that within the accuracy of the experiment, f^+ is constant. (Disser. Abstr.)

Strong (Baryon-Induced)

Refer also to abstracts 24084, 24518, 24519, and 24567.

24531 (JEN-174-DF/I-52) ESTUDIO DE LAS INTERACCIONES DE PROTONES DE 13'8 GeV/c CON LOS NUCLEOS PESADOS DE EMULSIONES. (Study of the Interaction of 13.8 GeV Protons with the Heavy Nuclei of Emulsions). Gomez Aleixandre, J. L. (Junta de Energia Nuclear, Madrid (Spain). Division de Fisica). [1966]. 19p. (In Spanish). Dep.

There were 145 stars analyzed with $N_h > 8$ produced by the interaction of 13.8-GeV/c protons with Ag and Br nuclei. The emulsion stack was irradiated in a 170-Kgauss magnetic field. Statistical results concerning the main characteristics of the different particles emitted are given and the energy balance is evaluated. The main features of both 24 GeV/c protons and 17 GeV/c π^- interactions are compared with those found for the 13.8-GeV/c protons interaction. (auth)

24532 (JINR-E1-3708) ELASTIC SCATTERING OF 660 MeV PROTONS ON LMN CRYSTALS. Chekh, Ya.; Yanout, Z.; Legar, F.; Malek, Z. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1968. 21p. Dep.

Elastic and quasielastic 660 MeV proton scattering on various targets was investigated. Crystal LMN ($La_2Mg_3(NO_3)_{12} \times 24\ H_2O$), the equivalent dummy target consisting of $Ba(NO_3)_2$ (36.37%) and MgO (63.63%) and polythene were used as targets. The results can be used for the planning of the nucleon-nucleon scattering experiments on a proton polarized target. (auth)

24533 VERY LOW MULTIPLICITY JETS IN TeV REGION AND THEIR INTERPRETATION IN TERMS OF NUCLEON ISOBARS. Rybicki, Krzysztof (Inst. of Nuclear Research, Krakow). Nukleonika, 13: 61-5(1968).

Six very low multiplicity interactions of high energy (>1 TeV/nucl) nuclei in nuclear emulsion are described. They are well interpreted in terms of single nucleon–nucleon collision in which the incident nucleon excites to the isobar state with mass of about 2 GeV/c^2. This isobar subsequently decays producing one to three particles. (auth)

24534 HIGH ENERGY NUCLEAR INTERACTIONS WITH LOW ENERGY TRANSFER INTO SOFT COMPONENT. Wolter, Wladyslaw (Inst. of Nuclear Research, Krakow). Nukleonika, 13: 67-76(1968).

An analysis of two nuclear interactions with primary energy $\geq 10^{13}$ eV and with very low energy transfer into the soft component is presented. It seems that in these interactions the mean value of the transverse momentum of the produced particles and their angular distribution is much different for charged particles and neutral pions. Low energy transfer into the soft component seems to be correlated with interactions characterized by high multiplicity and low number of evaporation tracks. (auth)

24535 $pp \rightarrow pp\pi^+\pi^-$ INTERACTIONS AT 8.1 GeV/c. Kayas, G. (Institut de Physique Nucleaire, Orsay, France); Le Guyader, J.; Sene, M.; Yiou, T. P.; Alitti, J.; Nguyen Thuc Diem; Smadja, G.; Ginestet, J.; Manesse, D.; Tran ha Anh. Nucl. Phys., B5: 169-80 (1968).

At 8 GeV/c, the cross section for the reaction $pp \rightarrow pp\pi^+\pi^-$ is (2.46 ± 0.1) mb. The production of well known resonances is described: $\Delta^{++}(1236)$, $\Delta^0(1236)$, $N^*(1525)$, $N^*(1688)$. The presence of the $P_{11}(1470)$ resonance is also discussed. (auth)

24536 CROSS SECTION FOR ^{7}Be PRODUCTION FROM ^{12}C WITH PROTONS OF 3 TO 12.5 GeV. Stehney, A. F.; Steinberg, E. P. (Argonne National Lab., Ill.). Nucl. Phys., B5: 188-94(1968).

Determinations of $\sigma_C(^7Be)$ were made at seven proton bombarding energies between 3 and 12.5 GeV. The excitation function in this energy range is nearly constant with a slight downward trend from about 9.6 ± 0.8 mb at 3 GeV to 9.2 ± 0.8 mb at 12.5 GeV. (auth)

24537 ELASTIC PHOTOPRODUCTION OF π^0 MESONS FROM DEUTERIUM AROUND THE $N_{1}^{*}{}_{2}(1525)$ RESONANCE. Nakamura, T.; Hatano, S.; Henmi, Y.; (Kyoto Univ.); (and others). J. Phys. Soc. Jap., 24: 698-705(Apr. 1968).

The differential cross sections of the $\gamma + d \rightarrow \pi^0 + d$ reaction were measured at the pion angle of 50° in the cms and in the photon energy range from 650 to 820 MeV, for the purpose of estimating the isotopic vector part of the photopion production amplitude from nucleons around the second resonance, $N_{\frac{3}{2}}^{*}(1525)$.

Recoil deuterons were measured with the combination of the momentum analysis with a magnet and the time of flight measurement. The measured cross section together with data obtained in the previous experiment were analyzed basing on the impulse approximation. The s_{11}-, s_{31}-, p_{33}-, p_{11}-, and d_{13}-waves are included in the analysis. The results of analysis are consistent with the conclusion that the isotopic vector part is dominant in the d_{13}-wave amplitude of π^0 photoproduction from free nucleons around the $N^*_\eta(1525)$ resonance. (auth)

24538 DATA COMPILATION ON BARYON–BARYON INTERACTIONS. I. PROTON–PROTON COLLISIONS BETWEEN 1 AND 32 GeV/c. Alexander, G.; Bernary, O.; Maor, U. (Weizmann Inst. of Science, Rehovoth, Israel). Nucl. Phys., B5: 1-28(1968).

A data compilation on pp interactions is reported as the beginning of a systematic review of the strong-interaction properties of elementary particles. The list of references are followed by curves showing the total and elastic pp cross sections as a function of the incident momentum. Following are differential cross sections and polarization curves for various proton incident momenta. (L.B.S.)

24539 DOUBLE-REGGE-POLE MODEL ANALYSIS OF $pp \rightarrow \Delta^{++}p\pi^-$ AT 6.6 GeV/c. Berger, Edmond L. (Univ. of California, Berkeley. Dartmouth Coll., Hanover, N. H.).; Gellert, Eugene; Smith, Gerald A.; Colton, Eugene; Schlein, Peter E. Phys. Rev. Lett., 20: 964-7(Apr. 22, 1968). (UCRL-18110).

Reasonable fits to invariant-mass, momentum-transfer, and Treiman-Yang angle distributions for the reaction $pp \rightarrow \Delta^{++}p\pi^-$ at 6.6 GeV/c are obtained from a double-Regge-pole model with pion exchange. (auth)

24540 DIFFERENTIAL CROSS SECTIONS IN PROTON–PROTON SCATTERING AT 52.34 MeV. Sanada, J. (Tokyo Univ. of Education); Kuriyama, K.; Takeuchi, Y.; (and others). Nucl. Phys., B4: 379-91(1968).

A measurement of differential cross sections in proton–proton scattering at 52.34 MeV, of a higher precision than that of the measurement of 1961 was made at 29 angles from 14° to 90° c.m. angle. A large scattering chamber of sliding-cylinder type, hydrogen gas target and NaI(Tl) detectors were used. The total error of the differential cross sections was ±0.5% over most of the angular range. The agreement of the present results with recent results at 49.41 MeV is very good in the angular range greater than 20° c.m. angle in spite of the difference in method. (auth)

24541 MEASUREMENTS OF THE DIFFERENTIAL CROSS SECTION AND POLARIZATION IN PROTON–PROTON SCATTERING AT ABOUT 143 MeV. Cox, G. F. (Univ. of Birmingham, Eng.); Eaton, G. H.; Van Zyl, C. P.; Jarvis, O. N.; Rose, B. Nucl. Phys., B4: 353-73(1968).

The differential cross section and polarization in proton–proton scattering were measured over the angular range 16.6° to 113° c.m. at mean scattering energies of 144.1 and 140.7 MeV, respectively. The cross sections were determined to within a relative precision of ±0.5% and the absolute value of the 90° c.m. cross section was determined to ±0.7%. The asymmetry measurements were made to a precision of ±0.002 and the beam polarization is known from previous work to an accuracy of ±0.85% of its value. (auth)

24542 EXCHANGE MECHANISM FOR THE REACTION: $p + n \rightarrow \Delta^{++} + \Delta^-$. Cohn, H. O. (Oak Ridge National Lab., Tenn.); McCulloch, R. D.; Bugg, W. M.; Condo, G. T. Phys. Lett., 26B: 598-600(Apr. 1, 1968). (K-DP-3155).

In the reaction $p + n \rightarrow p + n + \pi^+ + \pi^-$ copious Δ^{++} and Δ^- production was observed at four-momentum transfers greater than 100 m_π^2 even when restriction was made to the double isobar overlap region. Such behavior is not observed in the analog $\bar{p}p$ and pp reactions, which strongly suggests the importance of a mechanism in addition to one pion exchange. (auth)

24543 ANTIPROTON–PROTON CHARGE-EXCHANGE DIFFERENTIAL CROSS SECTIONS BETWEEN 50 AND 180 MeV. Bizzarri, R. (Univ., Rome. Istituto Nazionale di Fisica Nucleare, Rome); Conforto, B.; Gialanella, G. C.; Guidoni, P.; Marcelja, F.; Castelli, E.; Ceschia, M.; Sessa, M. Nuovo Cim., 54A: 456-67(Mar. 21, 1968).

The angular distribution of the charge-exchange reaction $\bar{p}p \rightarrow \bar{n}n$ was measured for antiprotons of kinetic energy between 50 and 180 MeV. The measurement is based on 215 events in which the annihilation star of the antineutron is detected. The results are compared with the existing theoretical models. (auth)

24544 ANTIPROTON–PROTON ELASTIC SCATTERING BETWEEN 63 AND 175 MeV. Conforto, B. (CERN, Geneva); Fidecaro, G.; Steiner, H.; Bizzarri, R.; Guidoni, P.; Marcelja, F.; Brautti, G.; Castelli, E.; Ceschia, M.; Sessa, M. Nuovo Cim., 54A: 441-55(Mar. 21, 1968).

The $\bar{p}p$ elastic scattering differential cross sections were determined at nine energies between 63 and 175 MeV, from 11,000 scattering events measured in a hydrogen bubble chamber. The results are compared with existing theoretical models and good agreement is found with the calculations of Bryan and Phillips. (auth)

24545 INTERACTIONS OF COSMIC RAY NUCLEAR ACTIVE PARTICLES IN IRON AT MOUNTAIN ALTITUDE. Koch, John William. Ann Arbor, Mich., Univ. of Michigan, 1967. 91p. Thesis.

Nuclear interactions of particles of an average energy of 100 BeV were observed by means of a 60-in. cloud chamber operated at an atmospheric depth of 530 g/cm². The cloud chamber contained 168 g/cm² of iron in the form of 17 plates each ½-in. thick. The cloud chamber was located at the center of the BASJE extensive air shower array on Mt. Chacaltaya, Bolivia. A coincidence requirement selected charged particles which interacted in the iron. The detectors of the BASJE extensive air shower array were placed in anticoincidence to provide a bias against interacting particles which were accompanied by air showers. Below the cloud chamber was the BASJE 60-m² array of detectors shielded by 320 g/cm² of lead and concrete. The pulses from these detectors are a measure of the energies of the interacting particles. From the relative number of interactions in each plate, the interaction mean free path of charged nuclear active particles in iron of average energy 100 BeV is calculated to be 116 ± 18 g/cm². The pion to proton ratio of the interacting particles is estimated to be less than 0.10. This estimate is based on a measurement of the neutral to charged ratio. From the total number of interactions, an upper bound for primary protons of energy greater than 30 BeV incident upon the earth's atmosphere is calculated to be $3.3 \pm 0.9 \times 10^4/m^2$ hr sterad. (Disser. Abstr.)

Strong (Meson-Induced)

Refer also to abstract 24545.

24546 ENERGY ESTIMATION IN COLLISIONS OF VERY HIGH ENERGY PIONS WITH NUCLEI OF PHOTOGRAPHIC EMULSION. Gierula, Jerzy; Krzywdzinski, Stainslaw (Inst. of Nuclear Research, Krakow). Nukleonika, 13: 77-83(1968).

On the basis of about 500 interactions of particles with energy of few hundred GeV with nuclei of photographic emulsion a systematic dependence of the median emission angle of secondary particles on the number of evaporation prongs was found. In consequence the corrections to the energy estimates calculated by the Castagnoli method was obtained. (auth)

24547 THE Ξ^--HYPERONS PRODUCTION IN π^-N INTERACTIONS AT THE MOMENTUM OF 4.0 GeV/c. Atayan, M. R.; Bannik, B. P.; Grigoryan, N. G.; (and others) (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 7: 349-51(Feb. 1968). (In Russian).

Production of Ξ^--hyperons in propane bubble chamber from π^-N interactions at a momentum of 4.0 GeV/c is studied. The production cross section is found to be $1.5^{+0.7}_{-0.4}$ μb. The obtained data are compared with results of other experiments. (auth)

24548 PRODUCTION OF HYPERFRAGMENTS AND ^{8}Li FRAGMENTS IN INTERACTIONS OF MESONS (K^-) AT 10.1 GeV/c WITH EMULSION NUCLEI. Gerber, J. P. (Centre de Recherches Nucleaires, Strasbourg); Bechdolff, A.; Baumann, G.; Cuer, P.; Jousset, J.; Montret, M. Nucl. Phys., B5: 75-84(1968). (In French).

Some experimental data concerning hyperfragment and ^{8}Li fragment production in 10.1 GeV/c K^- meson interactions with emulsion nuclei are presented. Hyperfragment and ^{8}Li fragment production rates are found to be $(0.89 \pm 0.07) \times 10^{-2}$ and $(1.17 \pm 0.07) \times 10^{-2}$, respectively. The production characteristics are studied. (auth)

24549 CENTRAL AND PERIPHERAL INTERACTIONS IN PION–NUCLEON INELASTIC EVENTS AT 17.2 GeV. Kohli, J. M. (Panjab Univ., Chandigarh, India). Nucl. Phys., B4: 620-8(1968).

The present investigation is based upon 169 pure pion-nucleon interactions at 17.2 GeV. The experimental results based upon various parameters like effective target mass distribution, mean multiplicity, angular and energy distributions may be explained on the basis of a definite structure of nucleon. The incident pion may interact with the central "core" of the nucleon or with the pion of the virtual meson cloud surrounding the core itself. (auth)

24550 DOMINANT ROLE OF THE BARYON VARIABLES IN THE DESCRIPTION OF HIGH-MULTIPLICITY INTERACTIONS AT

HIGH ENERGY. Hofmokl, T.; Michejda, L.; Otwinowski, S.; Sosnowski, R.; Szeptycka, M.; Wojcik, W.; Wroblewski, A. (Univ. of Warsaw. Inst. of Nuclear Research, Warsaw). Nucl. Phys., B4: 573-9(1968).

It is shown that in the reactions: $\pi^+ + p \rightarrow p + 5\pi$ and $\pi^+ + p \rightarrow p + 6\pi$ at 8 GeV/c the secondary protons determine the general features of the pion distributions. (auth)

24551 π^+p INTERACTIONS AT 850 MeV/c. Debaisieux, J.; Dufour, P.; Grard, F.; Heughebaert, J.; Verbeure, F.; Windmolders, R. (Laboratoire Interuniversitaire Belge des Hauntes Energies, Brussels). Nucl. Phys., B5: 147-57(1968).

Experimental results are presented on π^+p interactions at 850 MeV/c incident momentum. Cross sections for the various reactions are given. The elastic differential cross section was fitted to a polynomial in cos θ and the resulting coefficients are compared to results at neighboring incident momenta. For the one-pion-production reactions, the (Nπ) effective mass distributions and the ratio of π^0 to π^+ production were compared to the predictions of several theoretical models. (auth)

24552 RESONANCE PRODUCTION IN 8 GeV/c π^+ INTERACTIONS IN HYDROGEN. Boesebeck, K. (Technische Hochschule, Aachen); Deutschmann, M.; Kraus, G.; (and others). Nucl. Phys., B4: 501-10(1968).

From the measurement of 30,000 two-prong and 30,000 four-prong events of 8 GeV/c π^+-p interactions, resonance production was studied. A peak is observed in the $(\pi^+\pi^0)$ mass distribution near 1630 MeV. No enhancement is observed in the $(\pi^+\pi^+)$ mass distribution in the reaction $\pi^+p \rightarrow n\pi^+\pi^+$. A broad enhancement from 1000 to 1400 MeV is observed in the $(\pi^+\pi^+\pi^-)$ effective mass distribution in the reaction $\pi^+p \rightarrow p\pi^+\pi^+\pi^-$; no clear evidence is seen for a splitting of this enhancement into the A_1 and A_2 mesons. Alternative decay modes of the A enhancement into $\pi\eta$, $\pi\eta'$ and $K\bar{K}$ are discussed. Evidence is presented for a (3π) resonance observed near 1660 MeV which appears to decay partly into (π^+f^0). A broad enhancement in the $(\pi^+\omega)$ mass distribution is observed near 1260 MeV. (auth)

24553 INTERACTIONS OF π^+-MESONS WITH PROTONS AT 2.34 GeV/c. Angelov, Nikola S.; Boyadzhiev, Aleksand'r B.; Zlateva, Antonina I.; Kerachev, Pavel P.; Penev, Vladimir N.; Semerdzhiev, Khristo I.; Khristov, Mikhail I.; Shklovskaya, Ala I. Izv. Fiz. Inst. Aneb, Bulg. Akad. Nauk., 16: 173-89(1967). (In Bulgarian).

Preliminary experimental data are given from the study of the π^+p-interaction at 2.34 GeV/c by means of a hydrogen bubble chamber 40 cm in diameter. Based on the statistics of 1500 events, data were obtained about the formation of ρ^+-mesons and N^{*++}-isobars as well as on their interference. Cross sections of different channels, with two charged particles in a final state are shown, and conclusions are drawn about the peripheral character of the interactions examined. (auth)

24554 PERIPHERAL FORMATION OF RESONANCES IN THE MESON–NUCLEON INTERACTION AT 2.34 GeV/c. Zlateva, Antonina I.; Penev, Vladimir N.; Shklovskaya, Ala I. Izv. Fiz. Inst. Aneb, Bulg. Akad. Nauk., 16: 191-203(1967). (In Bulgarian).

Experimental data are adduced about the formation of ρ-meson and nucleon isobars $N^{*++}(1238)$ in quasibipartical interactions of π^+-mesons with protons at an energy of 2.34 GeV. Experimental differential cross sections and the coefficients of the spin matrix $\rho_{mm'}$ are compared with those obtained theoretically. The experimental data tally better with the results of the one-meson model with absorption in initial and final states. (auth)

24555 SOME ASPECTS OF TRANSVERSE MOMENTUM IN 17.2 GeV PION–NUCLEON INTERACTIONS. Kohli, J. M. (Panjab Univ., Chandigarh, India). Nucl. Phys., B4: 443-9(1968).

On the basis of 169 pure pion–nucleon interactions, the behavior of transverse momentum distribution was studied. The average value of p_t is (344 ± 26) MeV/c. The dependence of $\langle p_t \rangle$ on multiplicity and emission angles in the c.m. system was also investigated. The experimental results can be well understood on the assumption that most of the pions come from both nucleon and boson resonant states. The definite structure of the nucleon also helps in explaining quite a few aspects of the transverse momentum. (auth)

24556 Ξ^-, Ω^-, AND ANTIBARYON PRODUCTION IN 10 GeV/c K^-p INTERACTIONS. Bartsch, J. (Technische Hochschule, Aachen); Deutschmann, M.; Hermanns, M.; (and others). Nucl. Phys., B4: 326-34(1968).

Production of $\bar{\Xi}^+$, Ω^- and antibaryons was studied in 10 GeV/c K^-p interactions. The $\Xi^*(1530)$ is produced in about 15% of the reactions with $\bar{\Xi}^+$ production. Four unambiguous examples of Ω^- production with decay into (ΛK) were observed: this gives a lower limit for the Ω^- production cross section of 2.5 μb. One example of anti-Xi has been found. Distributions and average values of transverse and c.m. longitudinal momenta are presented. (auth)

24557 PRODUCTION ANGULAR DISTRIBUTION OF $N^{*-}(1236)$. Singh, C. P.; Agarwal, B. K. (Allahabad Univ., India). Nuovo Cim., 54A: 497-9(Mar. 21, 1968).

An attempt is made to explain previous data obtained on $N^{*-}(1236)$ in the $\pi^- + p \rightarrow \pi^+ + \pi^- + n$ interaction at 2.36 GeV/c, in which both forward and backward peaking were observed. The production angular distribution is analyzed on the basis of a rescattering diagram, which has the nucleon and the ρ^0 as intermediate states in the s-channel and single-pion states in the t-channel. The calculated angular distribution curve is in qualitative agreement with the experimental histogram. (L.B.S.)

24558 THE REACTIONS $K^- + p \rightarrow \Sigma^- + \pi$ (+ π^0) NEAR 1755 MeV. Charlton, Gordon Randolph. College Park, Md., Univ. of Maryland, 1967. 139p.

Thesis.

From a hydrogen bubble chamber exposure to a K^- meson beam, the differential cross sections for the reactions $K^- + p \rightarrow \Sigma^+ + \pi^-$ and the total cross sections for $K^- + p \rightarrow \Sigma^\pm + \pi^\mp + \pi^0$ were measured at 902, 929, 947, 960 and 990 MeV/c. Very little momentum dependence of the two body cross sections and of the Σ^+ polarization were found in this interval, the mean polarization being $\overline{\alpha P} \simeq 0.5 \pm 0.1$. From the cross sections the $Y_1^*(1755) \rightarrow \Sigma + \pi$ branching ratio was estimated to be $0.01 \pm .01$. The three body final states are dominated by the excited hyperon states $Y_1^*(1385)$, $Y_0^*(1405)$, and $Y_0^*(1520)$, with no marked momentum dependences apparent. A branching ratio $Y_1^*(1385) \rightarrow \Sigma + \pi$ of $0.08 \pm .03$ was obtained. Although interference effects were observed which indicated that the sample of $Y_0^*(1520) + \pi^0$ events is contaminated by background amplitudes, the data were found to be in good agreement with the earlier results that the $Y_1^*(1755)$ has spin and parity $\frac{5}{2}^-$. (Diss. Abstr.)

24559 PRODUCTION OF CASCADE AND TWO-HYPERON FINAL STATES IN K^-d INTERACTIONS AT 2.24 GeV/c. Chandler, John Paul. Bloomington, Ind., Indiana Univ., 1967. 68p.

Thesis.

This thesis concerns the analysis of cascade, lambda-lambda, and sigma-lambda final states in a K^-d bubble chamber experiment performed at the Brookhaven Alternating Gradient Synchrotron. The partial cross sections for the various final states are tabulated and compared with previous results, either directly, or indirectly, assuming conservation of isotopic spin. The cross section for Ξ^-K^0p seems anomalously small (≤ 14 μ b). The cascade final states cannot be reached via the exchange of a single known meson. For most of these states the angular distribution of the cascade in the barycentric system is peaked in the forward direction, indicating the possible operation of a baryon exchange mechanism. Probable cascade-pion resonances are observed near 1530 MeV and 1700 MeV in the $\Xi\pi$KN final states. The former is well-known; the latter, seen only with charge –2, is the first evidence for a Ξ^* resonance with $I = \frac{3}{2}$. The $K^*(888)$ is also formed in these states and interferes constructively with both Ξ^* resonances. No evidence for any two-baryon resonances was found. The sigma-lambda vs. kaon-pion triangle plot exhibits a depopulation in the center, which is the region of greatest phase space density. A Monte Carlo event generation program, described in an appendix, was used to check whether this depopulation might be due to the formation of N^* or Y^* resonances. This appeared not to be the case. (Disser. Abstr.)

24560 A STUDY OF K^-p INTERACTIONS AT 4.1 AND 5.5 GeV/c: FINAL STATES INVOLVING TWO CHARGED PARTICLES WITH OR WITHOUT A VISIBLE Λ. Mott, Jack Edward. Evanston, Ill., Northwestern Univ., 1967. 108p.

Thesis.

The results obtained from a bubble chamber analysis of K^-p interactions at incident K^- momenta of 4.1 and 5.5 GeV/c are described. The main emphasis has been on the analysis of two body final states such as elastic scattering and those containing an observed Λ (i.e., $\Lambda\rho^0$, $\Lambda\omega$, $\Lambda\eta$, ΛX^0, $\Lambda\phi$, $Y_1^+(1385)\pi^-$ and $Y_1^+(1680)\pi^-$). The elastic scattering differential cross section was found to be well described by the exponential form $d\sigma/dt = \exp(a + b|t| + ct^2)$ where t is the square of the four-momentum transfer. The present experimental data showed no backward K^- scattering in the K^-p center of mass system. Since backward peaks could arise from baryon exchange, this is consistent with the fact that there is no known baryon which could be exchanged in K^-p elastic scattering. The most striking feature of the Λ final states is observation of a new resonance, namely the $Y_1^*(1680)$. This was observed at 5.5 GeV/c and decayed prominently into $\Lambda\pi^+$ and $Y_1^{*0}(1385)\pi^{+0}$. A common feature of the observed two body final states is that their production process is dominated by a peripheral mechanism which presumably arises from a single meson exchange process. In the cases of the $\Lambda\rho^0$, $\Lambda\omega$, $\Lambda\phi$, and $Y_1^+(1385)\pi^-$ the exchange mech-

anisms were investigated in terms of the density matrix formalism. In general, vector meson exchange appeared to be the dominant production mechanism. The observed cross sections were compared with predictions of the independent quark model and other symmetry schemes. In particular the amplitudes for $\Lambda\rho^0$ and $\Lambda\omega$ production are predicted to be equal when restricted to a peripheral process and this is well satisfied by the present experimental data. (Disser. Abstr.)

24561 Λ K^0 AND Σ^0K^0 ASSOCIATED PRODUCTION IN 1.5 GeV/C π^-P INTERACTIONS, AND Λ K_1 LIFETIMES. Yoder, Lavon Lee. Ann Arbor, Mich., Univ., of Michigan, 1963. 111p.

Thesis.

A report is given on an experiment to investigate certain properties of the Λ and Σ^0 hyperons and of the K^0 meson in the high energy interactions of π^- mesons with protons: $\pi^- + P \rightarrow \Lambda + K^0$ and $\Sigma^0 + K^0$. The primary quantities to be determined were the total cross sections and angular distributions for the Λ K^0 and Σ^0K^0 associated productions, the polarizations of the Λ and Σ^0 hyperons, and the mean lifetimes of the Λ hyperon and K_1^0 meson. The incident π^- mesons of momentum 1.508 Bev/c interacted with protons in a liquid hydrogen target. Events were detected by the charged decay modes $\Lambda \rightarrow \pi^- + p$ and $K^0 \rightarrow \pi^+ + \pi^-$ in a counter-controlled thin plate spark chamber. The events were analyzed in two stages. First, the particle paths were reconstructed from photographs taken with right-angle stereo views and then the kinematics of the event were completely calculated. Secondly, inconsistencies in the kinematics due to measurement errors were eliminated by forcing overdetermined quantities into agreement by a least squares method. The results for the cross sections and polarizations are based on samples of 476 Λ K^0 and 134 Σ^0K^0 events. Both the polarization distribution and the differential cross section for the Λ peak backward in the production center of mass system. The average value for the Λ polarization is $\bar{P}_\Lambda = -.76 \pm .14$. The Λ K^0 total cross section is $\sigma_{\Lambda K} = .241 \pm .023$ mb. The differential cross section for the Σ^0K^0 production has a small backward peak and an indication of a strong forward peak which is missed due to the geometry of the experimental arrangement. The statistics are too small to determine the Σ^0 polarization. The results for the lifetimes are based on samples of 453 Λ and 706 K_1^0 decays where the K_1^0 data includes events from the reaction $\pi^- + P \rightarrow (\Lambda + \pi^0) + K^0$ in addition to the events from the above reactions. The lifetimes obtained are $\tau_\Lambda = (2.47 \pm .18) \times 10^{-10}$ sec. and $\tau_{K_1^0} = (.88 \pm .05) \times 10^{-10}$ sec. (Disser. Abstr.)

24562 S-WAVE ππ SCATTERING IN π−p INTERACTIONS AT 2.7 AND 4.2 GeV/c. Johnson, Philip Bruce. Lafayette, Ind., Purdue Univ., 1967. 123p.

Thesis.

Exposures of approximately 20,000 pictures at 2.7 GeV/c and 60,000 pictures at 4.2 GeV/c were examined for two-pronged final states which satisfy the hypotheses $\pi^-p \rightarrow \pi^+\pi^-n$ and $\pi^-p \rightarrow \pi^0\pi^-p$. The events which fall into the effective mass region dominated by ρ production are compared by means of production and decay angular distributions to a one-pion-exchange model which includes absorption effects and effects due to interference between the ρ and an I = 0, J = 0 amplitude. The data and model are found to be in good agreement. The model is utilized to calculate ππ S-wave elastic scattering phase shifts from .6 to .84 GeV/c^2 in the dipion effective mass spectrum. The results indicate that the I = 2 amplitude is small and negative below .75 GeV/c^2 and that the I = 0 amplitude is a slowly increasing function of the dipion effective mass. (Disser. Abstr.)

24563 K^* PRODUCTION IN HIGH ENERGY K^-p INTERACTIONS. Schweingruber, Frank Laverne. Evanston, Ill., Northwestern Univ., 1967. 109p.

Thesis.

The results obtained from a bubble chamber analysis of K^-p interactions at incident K^- momenta of 4.1 and 5.5 GeV/c are presented. The $\bar{K}^0\pi^+$N final states were studied extensively and the most prominent feature of these is the production of $K^*(890)$ and $K^*(1400)$ resonances. The $\bar{K}^0\pi^-\pi^+$N final states were investigated to measure the decay of $K^*(1400)$ into $K^*(890)\pi$ and Kρ. A brief survey of the present experimental knowledge and theoretical understanding of K^* production is given. The experimental details of the analysis are then discussed, including descriptions of the high momentum separated beam to the 30'' hydrogen bubble chamber at the ZGS and the data processing system used for this analysis at Argonne National Laboratory and Northwestern University. This was the first high energy K run in the 30'' chamber and the first experiment using this data analysis system, therefore many checks were made that the analysis contained no systematic errors. Evidence for quasi two-body production of $K^*(890)^-$, $K^*(1400)^-$ and $K^*(1800)^-$ is presented from the two-prong events where the positive track can be identified as a proton $K^*(890)^-$ and $K^*(1400)^-$ are also observed in the two-prong-plus-V topology where the K^0 decay is observed. For missing neutron reactions, a study was made of the missing mass distributions to prove that the kinematical fits to $K^-\pi^+n$ and $\bar{K}^0\pi^-\pi^+n$ final states could confidently be used to study $K^*(890)^0$ and $K^*(1400)^0$ production. $K^*(890)^{-0}$ production and decay angular distributions are analyzed in terms of the spin density matrix and the absorptive peripheral model. Vector exchange is dominant in $K^*(890)^-$ production while $K^*(890)^0$ is formed mainly by pseudoscalar exchange. The results are in good agreement with the ρ and ω couplings predicted by SU(6). An absorptive peripheral model calculation using these coupling constants gives a good fit to the $K^*(890)^{-0}$ density matrix elements as a function of production angle. Mass, width, and decay branching ratios into Kπ, $K^*(890)\pi$, and Kρ are given for the $K^*(1400)$ resonance as observed in our data. The branching ratios obtained are in agreement with those predicted from SU(3) using known A_2 and f_0 decay rates and assuming the $K^*(1400)$ is a member of a 2^+ nonet. The absorptive peripheral model gives no reasonable fits to the $K^*(1400)$ production angular distributions. The $K^*(1400)^{-0}$ production and decay angular distributions suggest that the spin-parity of the $K^*(1400)$ is 2^+, but without many more events or a better model for the production mechanism we cannot make a decisive determination. (Disser. Abstr.)

24564 Λ-HYPERON BINDING ENERGY IN NUCLEAR MATTER. Lou, Alice Yuan-ning. Los Angeles, Univ. of California, 1967. 164p.

Thesis.

The experimental studies of the binding energy (B_Λ) of heavy hypernuclei ($16 < A \leq 100$) produced by the interactions of 800 MeV/c K^--mesons with the heavy nuclei (Ag and Br) of nuclear emulsions are described. Both K2 and K5 nuclear emulsions are used. A better correlation of the B_Λ's with the mass numbers (A) of the heavy hypernuclei is required in order to determine B_Λ^s (the saturation value of B_Λ for heavy hypernuclei) and D_Λ (the well-depth of the Λ-nucleon potential). Consequently, the study of the production mechanism of heavy hypernuclei is considered. A Monte Carlo calculation based on the assumption that these hypernuclei are the spallation products of K^- interactions with the heavy nuclei of the emulsion was carried out. The production features predicted from this calculation are in good agreement with those observed experimentally except for the range distribution of heavy hypernuclei. This observed discrepancy is considered to be due to the rough approximation in the computation in simulating the cascade stage. A more refined simulation of this stage is impossible due to lack of experimental data in the Λ-nucleon scattering cross sections in the high energy region. However, in spite of this shortcoming, the calculation indicates that the spallation model can still be regarded as a reasonable approximation to the production mechanism of heavy hypernuclei. A Saxon-well potential was assumed in the attempt to obtain a well-depth D_Λ as close to the true value as possible. D_Λ was found to be approximately (27 ± 2) MeV. The saturation of the binding energy of the Λ-hyperon in heavy hypernuclei is found to occur very gradually. Due to a lack of π−p−r (mesic decay through π−proton-recoil decay mode) events, the value of D_Λ obtained cannot be regarded as conclusive. In the study, only one π−p−r event was found, since the ratio of nonmesic/mesic decay rate is approximately 200 to 1 as discussed later. However, it does give a close approximation to the true value of D_Λ. (Disser. Abstr.)

24565 ANALYSIS OF COHERENTLY PRODUCED THREE PION STATES AT 16 GeV/c. Moriyasu, Keihachiro. Berkeley, Calif., Univ. of California, 1967. 76p.

Thesis.

The three-pion final states, $\pi^+\pi^-\pi^-$ and $\pi^-\pi^0\pi^0$, coherently produced on heavy nuclei by a π^- beam at 16 BeV/c were studied. Both charged and neutral ρ meson formation in the 2π channels and a strong A_1 enhancement in the 3π system were observed. The general features of the A_1 seen in the two 3π channels appeared to be compatible although the A_1 in the data is wider than that seen in other experiments. It was shown from various tests that the enhancement in the data is inconsistent with the suggestion that the A_1 is the result of a purely kinematic effect. From a detailed study of the Dalitz-plot densities and decay angular distributions, it was determined that the most probable value for the spin-parity of the A_1 is 1^+. (Disser. Abstr.)

24566 A STUDY OF $\pi^-p \rightarrow \omega n$, ϕn AT 2.10 GeV/c AND π^-p ELASTIC SCATTERING AT 1.89 AND 2.10 GeV/c. Boyd, James Hamilton. Madison, Wis., Univ. of Wisconsin, 1967. 171p.

Thesis.

In a bubble chamber experiment at 2.10 BeV/c the cross section $\sigma(\pi^-p \rightarrow \omega n) = 1.41 \pm 18$ mb was determined by fitting the neutral and the charged effective mass spectra for events of the type $\pi^-p \rightarrow \pi^+\pi^-n$ (m) π^0; m ≥ 1 with appropriate phase space and resonance effective mass distributions. Cross sections for other contributing reactions are also given. The cross section ($\pi^-p \rightarrow$

ϕn) = $19^{+}_{-}{}^{4}_{5}$ μb (statistical error) was obtained by using the maximum likelihood method to determine the cross section corresponding to a peak (at the ϕ mass 1019.5 MeV) in the K^+K^- effective mass spectrum of K^+K^-n events. The relative probability of the cross section being zero is .07. It is concluded that $\sigma(\pi^-p \rightarrow K^+K^-n)$ is between 75 and 150 μb at 2.10 BeV/c. The K-pair events studied include both events with and without a K-decay. The non-decay event identification procedure included a visual bubble density estimation. An $\omega-\phi$ mixing angle of 42.1 ± 1.4° was calculated (statistical error) using a quark model prediction of Lipkin and Scheck. This mixing angle prediction agrees well with values calculated from SU(3) mass formulas. The input data for this calculation are the ϕn and the ωn cross sections at the ωn center of mass energy 1.96 BeV which were estimated from $\pi^+n \rightarrow \omega p$ data. The π^-p elastic scattering differential cross sections from bubble chamber experiments at 1.89 and 2.10 BeV/c are presented. Expansions of the differential cross sections in Legendre polynomials are given. The diffraction peak fits e^{At}, with A = 7.68 ± .37 (BeV/c)^2 at 1.89 BeV/c and 7.68 ± .16 (BeV/c)^2 at 2.10 BeV/c. Plots of $d\sigma/dt$ at the two momenta agree within statistics. The π^-p elastic cross section is 9.38 ± .42 mb at 1.89 BeV/c and 9.95 ± .36 mb at 2.10 BeV/c. Attempts to fit this and other πp scattering data between 1.7 and 2.5 BeV/c using a strong absorption optical model to obtain starting values for phase shift searches are described. The solutions obtained are not of sufficient quality to verify the spins and parities of pion nucleon resonances in this energy region. (Disser. Abstr.)

Particle Interactions and Properties (Theoretical)

General

Refer also to abstract 24036.

24567 (AED-C-23-24) HIGH ENERGY PHYSICS INDEX. Volume 6, No. 3 (1029-1702). (Zentralstelle fuer Atomkernenergie-Dokumentation, Frankfurt am Main (West Germany)). 1968. 258p. Dep.

A monthly report of material received at DESY is presented. This material, which covers experimental and theoretical physics, includes weak, electromagnetic, and strong interactions, strange particles, accelerators, methods and instruments, symmetry principles and field theory. (J.F.P.)

24568 (ITF-67-31) DYNAMIC MOMENTS AND CURRENT ALGEBRAS. Shirokov, Yu. M. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1967. 19p. (CONF-670544-8). Dep.

From Conference on Axiomatic Quantum Field Theory and Elementary Particles, Kiev, USSR.

An investigation is made of some rigorous physical and mathematical properties of dynamic moments. The method provides the possibility of deriving discrete mass spectra without contradictions with theorems like that of O'Raifeartaigh. It is essential to note that these symmetries occur in bound states only rather than in reactions. Tentative suggestions about the choice of the system of commutators, and the gravitational current and its possible role in current algebras are also considered. (J.F.P.)

24569 (KFKI-3/1968) FAMILIES OF REGGE TRAJECTORIES AT NONVANISHING ENERGY. I. Domokos, G.; Suranyi, P. (Magyar Tudomanyos Akademia Kozponti Fizikai Kutato Intezete, Budapest). [1968]. 17p. Dep.

The parent-daughter trajectory phenomenon is studied for spinless particles in the framework of the Bethe-Salpeter equation. If the kernel of the equation satisfies some natural conditions, the partial wave amplitude is shown to possess multiple poles in the l-plane, corresponding to a Regge-pole family. Under the same conditions a perturbation formula is given for the derivatives of trajectory functions and residues at zero momentum transfer as a function of $\varkappa$, the order of daughter trajectories. (auth)

24570 (UCRL-17876) PHYSICS SEMIANNUAL REPORT, MAY-OCTOBER 1967. (California Univ., Berkeley. Lawrence Radiation Lab.). Nov. 1967. Contract W-7405-eng-48. 117p. Dep. CFSTI.

A summary of research at the Lawrence Radiation Laboratory from May through October, 1967, is presented. This research covers both theoretical and experimental high-energy physics and nuclear physics. Computing and data handling and accelerator operation and development are also covered. (J.F.P.)

24571 (LA-tr-68-6) ANALYSIS OF MICROCAUSALITY. Blokhintsev, D. I.; Kolerov, G. I. Translated by A. D. Cernicek (Los Alamos Scientific Lab., N. Mex.), from Paper Presented at Mezhdunar. Konf. Fiz. Vys. Energ., 12th, Dubna, USSR, 1964, 2: 236-8(1966). 8p. (CONF-550-101). Dep. CFSTI. JCL $1.10 fs, $0.80 mf.

It is stated a priori that there is no reason to believe that metric relations in the region of small scales should be such as they are known to be from microscopic physics. Meanwhile if one proceeds from the metrics of the Einstein-Minkowski space, then it is noted that an assumption that the signal for large distances is transmitted by the particles with positive mass leads to the Green functions which disappear inside the light cone and have a singularity of the type $\delta(x^2)$ in this cone. On the other hand, in view of the indefinite character of the metric the introduction of any scale a, where a is elementary length, proves to be insufficient for the description of that region of space science inside of which the usual metric and causality can or may be distorted. It is also necessary to have in its arrangement a time vector $n(n^2 = 1)$, which allows the determination, in an invariant manner, of the concept of nearness of two points in the Einstein-Minkowski space. The cases of πN scattering at high energies and the elastic scattering of electrons are mentioned. (J.F.P.)

24572 MOESSBAUER EFFECT AND THEORY OF QUANTIZED SPACE-TIME. Kirzhnits, D. A.; Chechin, V. A. (Lebedev Inst. of Physics, Moscow). Yadern. Fiz., 7: 431-9(Feb. 1968). (In Russian).

A possibility of determining an upper limit to the elementary length from Mössbauer experiments is discussed. The radiation of a charged particle in the oscillator potential well is investigated in detail according to the theory of quantized space-time. It is found that the corresponding transition line has its peculiar width due to effects of nonlocality. Comparing this width with the width shown by the Mössbauer effect it is established that the elementary length in the considered theory does not exceed 10^{-20} cm. (auth)

24573 ENERGY DISTRIBUTIONS OF THREE-PION DECAYS. Narodetskii, I. M. (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz., 7: 418-30(Feb. 1968). (In Russian).

Coordinates ρ, A, λ convenient to analyze three-pion decays of unstable particles are introduced. Within these variables the wave functions Ω^J_M are constructed describing the three-pion state with the total momentum J, with the projection M of the momentum to the the z axis and possessing a definite form of symmetry. The way to construct distributions on the Dalitz plot is shown. (auth)

24574 EIGENVALUES OF CASIMIR OPERATORS. Popov, V. S.; Perelomov, A. M. (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz., 7: 460-9(Feb. 1968). (In Russian).

Generating function of the Casimir operators for all classic groups is found. With its help, the eigenvalues of $C_p(m)$ for arbitrary irreducible representation with the highest weight m are presented as a series in power sums S_k or $\tilde{S}_k$. Coefficients of this series are tabulated for all values $p \leq 6$. The results obtained are generalized to the case of an arbitrary semi-simple Lie group and explicit formulas for the operators C_p for the group G_2 are given. (auth)

24575 ON THE INTEGRAL TRANSFORMATIONS CONNECTED WITH THE KLEIN-GORDAN EQUATION. Smorodinskii, Ya. A.; Surkov, E. L. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 7: 454-9(Feb. 1968). (In Russian).

Integral transformations relating functions on the cone $k^2 = 0$ to the solutions of the Klein-Gordan equation $(\hat{p}^2 - m^2)\varphi(x) = 0$ are obtained. Wave functions $\varphi(x)$ are decomposed over the components irreducible under the Lorentz group in various coordinate systems. Integral transformations relating the hyperboloid $p^2 = 1$ with the solution of the d'Alembert equation are given. (auth)

24576 RELATIONSHIPS BETWEEN THE MASSES OF SUBATOMIC PARTICLES. Saleem, M. (Punjab Univ., Pakistan). Nature (London), 218: 158-9(Apr. 13, 1968).

Reference is made to the communication of D. T. Lewis (Nature 216: 573(1967)) in which it is suggested that the so-called elementary particles are composed of "tamaids" and pions, and in which equations are given for calculation of the masses of the various neutral and charged particles. Excellent agreement between theory and experiment was claimed. The present author analyses Lewis' assertions, and finds that agreement is extremely poor; also that Lewis omitted to consider many types of particles, and neglected many forbidden regions. It is concluded that Lewis' theory can only be acceptable if there are no forbidden regions. (UK)

24577 ASYMMETRY MOMENTS OF ANGULAR DISTRIBUTIONS. Kielanowski, P.; Werle, J. (Univ. of Warsaw). Nucl. Phys., B4: 682-8(1968).

The conventional harmonic analysis of the experimental angular distribution function requires cumbersome integrations with suitable weight functions [$P_n(\cos\theta)$, $Y_m^n(\theta,\varphi)$ or $e^{im\varphi}$]. A much simpler analysis of the experimental data is proposed with the help of asymmetry moments. It is shown that the value of a suitable asymmetry moment may be used as a parity or spin test. (auth)

24578 NUMEROLOGY OF THE CONSTANTS OF NATURE. Gamow, G. (Univ. of Colorado, Boulder). Proc. Nat. Acad. Sci. U. S., 59: 313-8(Feb. 1968).

The present status of the numerical relations between various fundamental constants of nature are surveyed. In discussing these constants it is convenient to use for three dimensionally independent basic units the velocity, the action, the values of which must be an integer of the barred quantum constant, and the length characterizing the range of strong nuclear interactions. A list of the important constants of nature expressed in this system is given. (J.F.P.)

24579 METHOD FOR DERIVING ANGULAR CORRELATIONS FOR PARTICLE PRODUCTION AND DECAY. Osborne, L. S. (Univ., Rome). Nuovo Cim., 54A: 375-406(Mar. 21, 1968).

A general method using vector operators is derived to obtain angular correlations between particles being produced by collisions and their subsequent decay if present. The expressions are in vector form for easy appreciation. The method is applied to general reactions and decays with specific examples for π-photoproduction, ρ-meson production, N^*-production, ρ-π peripheral production, and 3π production by e^+e^- annihilation. (auth)

24580 A FORTRAN PROGRAM FOR CALCULATING KINEMATIC AND DYNAMIC QUANTITIES OF PARTICLE INTERACTIONS AND DECAYS. Trower, W. Peter (Univ. of California, Berkeley). J. Comput. Phys., 1: 144-5(Nov. 1966).

A computer program that calculates relativistic kinematics and dynamics of particle interactions and allows a wide latitude in the choice of input variables and an extensive output that covers most normal needs is described. Symbolically the interaction for which this program KINE is constructed can be written as $1 + 2 \rightarrow 3 + 4$, where particle 2 is assumed to be at rest in the laboratory frame. The program essentially generates tables of kinematic and dynamic variables. Depending on the input, its output consists of the kinetic energies, momenta, and angles of particles 3 and 4 in both frames, as well as their η, β, and $d\Omega_{lab}/d\Omega_{cm}$. In addition, the η, β, and γ of the center of mass, the relative velocity, phase space, and total opening angle of the final-state particles, and the threshold energy and momentum of the incident particle are calculated. (J.F.P.)

24581 WAVE EQUATION FOR ZERO REST-MASS PARTICLES. Sen Gupta, N. D. (Tata Inst. of Fundamental Research, Bombay). Nucl. Phys., B4: 147-52(1968).

It is shown that $\{(\gamma\cdot\partial/\partial x) + \frac{1}{2}\chi(1 \pm \gamma_5)\}\psi_\pm = 0$ may also be taken as the wave equation for zero rest mass, spin $\frac{1}{2}$ particles. The new parameter is a measure of the degree of chirality. The investigations of the invariance properties of the equation lead to the same as those of the usual two-component neutrino theory with the exceptions of γ_5 invariance. It seems plausible that at least one of the neutrinos satisfies this kind of wave equation. (auth)

Electromagnetic

Refer also to abstracts 24079, 24571, 24616, and 24737.

24582 (DESY-68/4) VECTOR MESON DOMINANCE AND POLARIZATION. Fraas, H.; Schildknecht, D. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Jan. 1968. 16p. Dep.

The vector dominance model relates amplitudes for reactions induced by photons (e.g., π-production) to amplitudes for reactions induced by vector mesons. In the application of such relations one conventionally assumes that the vector mesons have to be polarized transversely with respect to the cms. Because of the spin rotation of a massive particle under Lorentz transformations, this choice is not well justified a priori. The main assumptions are, that the vector meson couples to a conserved current, and that for large s, the invariant amplitudes $A^{(i)}(s,t)$ $(i = 1, \ldots 6)$ are slowly varying functions approximately independent of the mass of the vector mesons. It is found that for large s and for both small and large t the optimum approximation of the photoproduction amplitudes is obtained if the vector mesons are in the transverse helicity states (with respect to the cms). Indeed, exactly these transverse amplitudes are independent of λ for $s \gg \lambda^2$, if the contribution of $A^{(6)}(s,t)$ is assumed to be small, in addition to the assumptions mentioned above. (auth)

24583 (JINR-P2-3753) MATRITSA RASSEYANIYA KVANTOVOGO ZARYAZHENNOGO POLYA POLEM PLOSKOI ELEKTROMAGNITNOI VOLNY. (Scattering Matrix of the Quantum Charged Field by the Electromagnetic Plane Wave). Barbashov, B. M.; Pervushin, V. N. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1968. 10p. (In Russian). Dep.

An exact value of the S-matrix, determining the scattering of the quantum charged particles by the electromagnetic plane wave field, was found. It is shown that the polarization effects of vacuum lead to nonessential phase factor in the S-matrix. The obtained S-matrix leads only to elastic forward scattering of particles. (auth)

24584 MOTION OF ELECTRIC CHARGES WITH ORDINARY AND RELATIVISTIC VELOCITIES. Linkovskii, Zh. B. Tr. Teor. Polya, 1: 97-106(1964). (In Russian).

An approximate method is developed for numerically integrating some nonlinear differential equations of n-th order in a finite interval of variation of the independent variable or in a specified interval of the unknown function. The method consists of a step by step integration of the equation, and in each sufficiently small step the coefficient of the equation and the free term are assumed to be constant and equal to their value at the beginning of the step. Thus, at each step, the problem reduces to integration of a linear equation with constant coefficients, which is carried out in quadratures, and to a determination of the corresponding integration constants from the conditions at the start of the step. The method is applicable to quasilinear equations, i.e., to equations that are close to linear. An estimate is made of the upper limit of the error of the method. The application of the considered approximate method to a study of trajectories of relativistic electrons is described. The method is convenient for electronic computer programming. (JPRS)

24585 NOTE ON THE DEPENDENCE OF INDUCED SYNCHROTRON RADIATION ON PROPERTIES OF EXTERNAL RADIATION. Zhukovskii, V. Ch.; Sokolov, A. A.; Ternov, I. M.; Khalilov, V. R. (Moscow State Univ.). Yadern. Fiz., 7: 368-74 (Feb. 1968). (In Russian).

The dependence of the induced synchrotron radiation on the polarization, frequency, and the spectral width of the external radiation is investigated. (auth)

24586 INTERMEDIATE BOSON PRODUCTION IN COLLIDING ELECTRON-POSITRON AND ELECTRON-ELECTRON BEAMS. Choban, E. A. (Leningrad Polytechnic Inst.). Yadern. Fiz., 7: 375-84(Feb. 1968). (In Russian).

Intermediate W-boson production in colliding e^-e^+ and e^-e^- beams in the processes $e^- + e^\mp \rightarrow e^\mp + W^- + \nu_e$ is studied. Angular distributions of intermediate bosons and the total cross sections of the processes at different energies of colliding particles and intermediate boson masses are obtained. The asymmetry in the angular distributions of the process $e^- + e^+ \rightarrow e^+ + W^- + \nu_e$ is discussed and the graph of the asymmetry degree dependence on the colliding particle energy at different masses of the intermediate boson is given. It is shown that the cross section of the process $e^- + e^+ \rightarrow e^- + W^+ + \nu_e$ coincides with that of the process $e^- + e^+ \rightarrow e^+ + W^- + \nu_e$. For the processes under consideration unitarity limits are found. (auth)

24587 PRODUCTION OF A PAIR OF PARTICLES WITH THE SPIN 3/2 IN COLLIDING e^-e^+ BEAMS. Shakhnazaryan, Yu. G. Yadern. Fiz., 7: 385-8(Feb. 1968). (In Russian).

The reaction $e^- + e^+ \rightarrow \frac{3}{2} + \overline{\frac{3}{2}}$ with arbitrarily polarized electrons and positrons is theoretically investigated. The expressions for differential cross section in arbitrary coordinate system and in the cms are obtained taking into account the form factors of particles produced. Some particular cases of initial particle polarizations are considered. (auth)

24588 CONTRIBUTION FROM THE COMPTON GRAPH TO THE LEPTON-PAIR PHOTOPRODUCTION CROSS SECTION. Boreskov, K. G.; Ter-Martirosyan, K. A. (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz., 7: 389-93 (Feb. 1968). (In Russian).

Contribution from the Compton graph to the symmetric lepton-pair photoproduction cross section is estimated from the experimental data on the ρ^0-meson photoproduction. The significance of the experimental resolution in the lepton angles and energies for the analysis of the results is indicated. (auth)

24589 COMMUTATORS OF THE ELECTROMAGNETIC FIELDS AND CURRENTS. Geshkenbein, B. V. (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz., 7: 440-4(Feb. 1968). (In Russian).

The equal-time commutators and the time-ordered products of the electromagnetic fields and currents are discussed. (auth)

24590 NATURE OF THE DECAY $\eta \rightarrow 2\gamma$. Panchapakesan, N.; Welling, D. J. (Univ. of Wisconsin, Milwaukee). Phys. Rev. Lett., 20: 945-6(Apr. 22, 1968).

If the interaction for the 3π decay is assumed to transform like the third member of an octet under unitary symmetry, it is possible to explain the behavior of the matrix element for the decay which appears to be linear in the odd-pion energy. It is suggested that this type of interaction also seems to be successful in relating the decays $\pi^0 \to 2\gamma$ and $\eta \to 2\gamma$. (J.F.P.)

24591 SUM RULES AND THE ELECTROMAGNETIC MASS DIFFERENCE OF PIONS. Cook, C. L.; Evans, L. E.; Han, M. Y.; Lipshutz, N. R.; Straumann, N. (Duke Univ., Durham, N. C.). Nucl. Phys., B5: 140-6(1968).

Using the algebra of currents, it is shown that the electromagnetic pion mass-difference diverges in the soft-pion limit if the usual spectral sum rules are assumed. An altered sum rule is proposed which makes the result finite and in close agreement with experiment. (auth)

24592 QUASIPOTENTIAL DESCRIPTION OF THE NEGATON–POSITON INTERACTION. Desimirov, G. M.; Mateev, M. D. (International Centre for Theoretical Physics, Trieste, Italy). Nucl. Phys., B4: 649-56(1968).

The negaton-positon interaction is investigated to second order in the coupling constant using the quasipotential approach to the quantum field theory. The quasipotential is constructed with the help of the two-time Green function. Terms depending on the energy are obtained. Their possible influence on the positonium energy levels is briefly discussed. (auth)

24593 SPECTRA OF $K_{\mu 4}$ DECAYS. Schilcher, K. (American Univ. of Beirut). Nucl. Phys., B5: 85-92(1968).

The K_{μ_4} decay spectrum and decay rate are calculated using current-algebra results for the form factors. (auth)

24594 ON THE PHOTOPRODUCTION OF NEUTRAL VECTOR MESONS AT HIGH ENERGIES. Matinyan, S. G. (Inst. of Physics, Tbilisi, USSR. Inst. of Physics, Erevan). Izv. Akad. Nauk Arm. SSR, Ser. Fiz., 2: 358-63(1967). (In Russian).

Photoproduction of neutral vector mesons at high energies is considered in the Regge pole model. All possible 2^+-nonet's trajectories are taken into account. The residues of poles are calculated on the basis of the $U(3) \times U(3)_\beta$ algebra. Qualitative agreement with experiment is achieved. (auth)

24595 PROTON FORM FACTORS. Drell, Sidney D. Comments Nucl. Particle Phys., 2: 36-40(Mar.-Apr. 1968).

Various attempts at providing a theoretical basis for the large momentum-transfer behavior of the proton form factor are reviewed: the ρ^0 dominance model; the dispersion theory approach; and the Lagrangian formalism. A less sophisticated approach based on the Schroedinger equation is outlined, in which the proton electromagnetic form factor is considered as the Fourier transform of the charge distribution. (L.B.S.)

24596 PROTON–PROTON BREMSSTRAHLUNG AT 20 MeV, 35^0: THEORY. Signell, P. (Michigan State Univ., East Lansing); Marker, D. Phys. Lett., 26B: 559-61(Apr. 1, 1968).

Proton-proton bremsstrahlung predictions from the Hamada-Johnston and Tabakin potentials are found to be in close agreement with each other, with the on-energy-shell approximation, and with the experimental value at 20 MeV, 30°. The Coulomb interaction is included in the on-shell approximation. The Low approximation is also examined. (auth)

24597 ρ-MESON COUPLINGS AND CURRENT ALGEBRA. Ahmed, M. A. (Univ. of Durham, Eng.). Nucl. Phys., B4: 249-56(1968).

Starting from the Fourier transform of the matrix of the retarded product of the isovector current with the ρ field a number of sum rules are derived. Approximate saturation leads to a relation expressing the ρNN^{**} coupling terms of the ρNN and ρNN^*_{33} couplings. (auth)

24598 CURRENT ALGEBRA AND $\eta \to 3\pi$. Bell, J. S.; Sutherland, D. G. (CERN, Geneva). Nucl. Phys., B4: 315-25 (1968).

A critical review is given of developments in the theory subsequent to the demonstration that in first approximation $\eta \to 3\pi$ is forbidden. It remains difficult to understand the process with conventional ideas without reducing to an accident the success of current algebra, and a simple linear matrix element, in $K \to 3\pi$. (auth)

24599 DETERMINATION OF PARTICLE SCATTERING AMPLITUDES FROM NUCLEAR PHOTOPRODUCTION. Formanek, J.; Trefil, J. S. (CERN, Geneva). Nucl. Phys., B4: 165-79(1968).

Recent work on the extraction of resonance–nucleon scattering amplitudes from the cross section for the production of resonances from helium is extended to include photoproduction and also to include heavier target nuclei. It is found that from the reactions $\gamma + {}^4\text{He} \to \rho^0 + {}^4\text{He}$ and $\gamma + {}^{16}\text{O} \to \rho^0 + {}^{16}\text{O}$, the rho-nucleon scattering amplitude can be deduced, provided that the energy resolution of the experiment is good enough to fix the final state of the nucleus unambiguously. (auth)

24600 ELECTROMAGNETIC STRUCTURE OF THE PION. Bowcock, J. E.; Kannelopoulos, Th. (Univ., Tuebingen, Ger.). Nucl. Phys., B4: 417-24(1968).

The problem of determining an analytic function from a knowledge of its modulus on the boundary is investigated. Providing the function has no zeros and the phase is normalized at some point it is shown that a unique determination is possible. The formalism is then applied to the process $e^+ + e^- \to \pi^+ + \pi^-$ in order to obtain information on the charge radius of the pion and the p-wave phase shift for pion–pion scattering. (auth)

24601 THE MASS RELATION $m_A = \sqrt{2}\, m_\rho$ FROM CURRENT ALGEBRA AND THE KROLL–RUDERMAN THEOREM. Ragusa, S.; Zimerman, A. H. (Instituto de Fisica Teorica, Sao Paulo, Brazil). Nucl. Phys., B4: 462-6(1968).

Assuming that the low-energy s-wave photopion production amplitude is dominated by the axial meson, the Weinberg's relation $m_A = \sqrt{2}\, m_\rho$ is derived in the framework of current algebra. (auth)

24602 PHOTOPRODUCTION AND ELECTROPRODUCTION OF PIONS. III. ω AND B EXCHANGE IN LOW ENERGY π^0 PHOTOPRODUCTION. Berends, F. A.; Donnachie, A.; Weaver, D. L. (CERN, Geneva). Nucl. Phys., B4: 103-12(1968).

The inclusion of ω and B exchange in low-energy π^0 photoproduction is found to remove a long-standing discrepancy between experiment and theoretical prediction. The ωNN coupling constants are found to be in reasonable accord with those obtained elsewhere. (auth)

24603 PHOTOPRODUCTION AND ELECTROPRODUCTION OF PIONS. II. PHOTOPION PRODUCTION BELOW 500 MeV. Berends, F. A.; Donnachie, A.; Weaver, D. L. (CERN, Geneva). Nucl. Phys., B4: 54-102(1968).

Fixed-t dispersion relations are used to evaluate photopion production below 500 MeV, using conformal mapping techniques to solve the integral equations for the multipole transition amplitudes. Comparison is made with all existing experimental data in this energy region and agreement is excellent except for very low energy π^0 production, where there is a distinct discrepancy, which shows up because of the almost complete cancellation of different multipoles. Some general qualitative statements are made about photoproduction at higher energies, which are in accord with the experimental situation. (auth)

24604 PHOTOPRODUCTION AND ELECTROPRODUCTION OF PIONS. I. DISPERSION RELATION THEORY. Berends, F. A.; Donnachie, A.; Weaver, D. L. (CERN, Geneva). Nucl. Phys., B4: 1-53(1968).

The dispersion relation theory of photo- and electroproduction of pions is reviewed and extended, exploiting the parallel between the two. Analytic expressions are given for the Born terms of the individual electroproduction multipoles and for the important kernels in the integral equations for the photoproduction multipoles. A sum rule is derived for the latter, and a discussion given of the application of the theory to data analysis, the results of which will be presented in a subsequent paper. (auth)

24605 PHOTOPRODUCTION OF SOFT PIONS IN $\gamma + {}^3\text{He} \to \pi^+ + {}^3\text{H}$. Griffiths, D.; Kim, C. W. (Johns Hopkins Univ., Baltimore). Nucl. Phys., B4: 309-14(1968).

The algebra of currents and the partially conserved axial-vector current hypothesis are used in the soft-pion approximation for the process $\gamma + {}^3\text{He} \to \pi^+ + {}^3\text{H}$. The ${}^3\text{He}$ and ${}^3\text{H}$ nuclei are treated as "elementary" particles, the nuclear form factors required being obtained from electron-${}^3\text{He}$ and electron-${}^3\text{H}$ scattering experiments. The results are in good agreement with experiment at low momentum transfer. (auth)

24606 INTERFERENCE OF ρ^0 AND ω STATES IN $e^+e^- \to \pi^0\gamma, \eta\gamma$. Benfatto, G. (Univ., Rome). Nuovo Cim., 54A: 516-19 (Mar. 21, 1968).

The effect of the interference of ρ^0 and ω states on the cross sections for $e^+e^- \to \pi^0\gamma$ and $e^+e^- \to \eta\gamma$ interactions is examined in the quark model and in the SU(3) model. (L.B.S.)

24607 ON THE HIGH-ENERGY PHOTOPRODUCTION OF THE η-MESON IN A REGGE-POLE MODEL. Colocci, M. (Univ., Florence). Nuovo Cim., 54A: 504-11(Mar. 21, 1968).

The photoproduction of the η-meson on nucleons is investigated in the Regge-pole model. It is shown that no forward peak is expected in the differential cross section at high energies. (L.B.S.)

24608 WEINBERG SUM RULES AND THE PION ELECTROMAGNETIC MASS DIFFERENCE. De Alwis, S. P. (Cambridge Univ., Eng.). Nuovo Cim., 54A: 475-8(Mar. 21, 1968).

Weinberg sum rules used previously for calculating the $\pi^+ - \pi^0$ mass difference are examined and are shown to be inconsistent with each other. It is shown that a different sum rule is needed in order to obtain a convergent result. The $\pi^+ - \pi^0$ mass difference obtained is in better agreement with experiment. (L.B.S.)

24609 THE MEASUREMENT OF THE GYROMAGNETIC RATIO OF THE FREE ELECTRON: A FEASIBILITY STUDY. Gee, Martell J. Provo, Utah, Brigham Young Univ., 1967. 66p.

Thesis.

The attempts to measure the gyromagnetic ratio of the free electron are reviewed and criteria are presented which must be met by any successful measurement of g. A novel method of obtaining an initial asymmetry in the spin populations of an electron beam is proposed, and its use in an experiment designed to measure g is discussed. Apparatus has been built in order to carry out such a measurement. Preliminary experiments carried out in this apparatus are reported and discussed, and suggestions for completion of the experiment are given. (Disser. Abstr.)

Weak

Refer also to abstracts 24077 and 24586.

24610 (SLAC-PUB-216) RADIOS OF p-WAVE AMPLITUDES IN HYPERON DECAYS. (Revised Version). Weyers, J. (Stanford Linear Accelerator Center, Calif.). Sept. 1966. Contract AT(04-3)-400. 8p. Dep. CFSTI.

Assuming a current × current Hamiltonian and PCAC, it is shown that a strict pole approximation leads to predictions for the ratios of p-wave hyperon decays which are compatible with experiment. (auth)

24611 MUON ENERGY LOSSES DUE TO THE PAIR PRODUCTION. Kel'ner, S. R.; Kotov, Yu. D. (Moscow Engineering-Physics Inst.). Yadern. Fiz., 7: 360-7(Feb. 1968). (In Russian).

Muon distributions from the part of the energy transferred as well as the energy losses of muons due to the pair production are calculated. Corrections taking into account the pair production processes by collision with the atomic electrons are obtained. (auth)

24612 CURRENT ALGEBRA AND POSSIBLE VIOLATION OF THE $\Delta T = 1/2$ RULE IN NONLEPTONIC K-MESON DECAYS. Dolgov, A. D.; Zakharov, V. I. (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz., 7: 352-9(Feb. 1968). (In Russian).

The $K \to 3\pi$-decay amplitudes with $\Delta T = 3/2$ are considered in framework of the partially conserved axial current hypothesis. It is shown that if the primary weak interaction Hamiltonian is a product of charged currents then the derivation from the $\Delta T = 1/2$ predictions is about 15% in the $K^+ \to \pi^+\pi^+\pi^-/K_1^0 \to \pi^+\pi^-\pi^0$ branching ratio and the derivation is about 50% in ratio of the pion spectrum slopes for $K^+ \to \pi^+\pi^0\pi^0$ and $K^+ \to \pi^+\pi^+\pi^-$ (or $K_1^0 \to \pi^+\pi^-\pi^0$) decays. If the primary weak interaction Hamiltonian satisfies the $\Delta T = 1/2$ rule and the violations are due to electromagnetic corrections then here is a relation between the amplitudes with $\Delta T = 3/2$, $5/2$ in $K \to 3\pi$ and $K \to 2\pi$ decays. (auth)

24613 S-WAVE NONLEPTONIC HYPERON DECAYS AND MODELS OF BARYONS. Nakagawa, M.; Trofimenkoff, N. N. (Australian National Univ., Canberra). Nucl. Phys., B5: 93-108(1968).

S-wave non-leptonic hyperon decays via a current × current, V-A primary Hamiltonian are investigated in three non-relativistic bound-state models of baryons: a quark model, a three-triplet model, and a quartet model. The main dynamical assumptions are: (i) The S-wave decays are due to a pion emission accompanied by both a single- (constituent) particle and a two-particle transition with the other particles in the baryon bound state not being affected. (ii) The recoil energy momentum of the particles taking part in the pion emission can be neglected and the pion is emitted with zero energy-momentum. (iii) All the particles are in S-states. Under these assumptions the following main results are obtained: (i) The amplitudes satisfy the same sum rules as those obtained by the current-algebra-PCAC method. An illustrative argument is given to show why this "coincidence" is obtained. (ii) The single particle transition involves no 27 tensor of SU(3) and gives no contribution to the decay $\Sigma^+ \to n + \pi^+$. (iii) A necessary and sufficient condition for the suppression of the 27 part of the two-particle transition and of the decay $\Sigma^+ \to n + \pi^+$ is found. (iv) In order to fit the experimental results the contribution from the two-particle transition must be substantial in the quark and three-triplet models and must dominate the contribution from the single-particle transition in the quartet model. (auth)

24614 LIKE PION SPECTRA AND NONLINEAR EFFECTS IN $K \to 3\pi$ DECAYS. Eliezer, Sh. (Technion-Israel Inst. of Tech., Haifa); Singer, P. Nucl. Phys., B4: 607-19(1968).

The effects of a nonlinear matrix element on the like pion spectra in $K \to 3\pi$ decays are investigated. An effective σ model, which gives a good fit to the unlike pion spectra in all three $K \to 3\pi$ decays, is being used. The spectra are expressed as functions of the like pion kinetic energies, and alternatively, as functions of the Dalitz variables. Significant nonlinearity is expected in the kinetic energy spectrum of the like pion as well as in the x-variable distribution in τ' decay. The x-distribution in τ' and $K_2^0 \to \pi^+\pi^-\pi^0$ should be constant. (auth)

24615 RADIATIVE CORRECTIONS TO $K^\pm \to \pi^0 + \mu^\pm + \nu$ WITH FINITE NEUTRINO MASS. Wong, N. N. (Univ. of Alberta, Edmonton). Nucl. Phys., B5: 47-58(1968).

All the radiative corrections to the particle spectra are calculated to the second order in elementary charge e for the decay $K^\pm \to \pi^0 + \mu^\pm + \nu$ with finite neutrino mass. The infrared divergent terms arising from the real photon emission process are only partially cancelled by those from the virtual photon processes. Therefore the corrections contain a term which diverges logarithmically at the high energy end of muon (or pion) spectrum. This term is expected to make a significant contribution to the spectra of the pion and the muon if the charged lepton in the final state is relativistic. The ratios of the spectra with finite neutrino mass to that with zero neutrino mass for both muon and pion, and the ratio of energy correlations between them were calculated. (auth)

24616 ELECTROPRODUCTION OF INTERMEDIATE BOSONS. Weis, A. (NORDITA, Copenhagen); Kabir, P. K. Nucl. Phys., B4: 643-8(1968).

The cross section for electroproduction of intermediate bosons W is estimated by the covariant Weizsäcker-Williams method. Using the photoproduction cross sections of Reiss and Cha, the cross section at 20 GeV electron energy is 6.6 pb for a W-mass equal to two nucleon masses and 0.64 pb for a W-mass twice as large. (auth)

24617 K_{l3} FORM FACTORS AND SPECTRAL FUNCTIONS OF CURRENTS. Majumdar, D. P. (State Univ. of New York, Stony Brook). Phys. Rev. Lett., 20: 971-6(Apr. 22, 1968).

Employing the usual techniques of the algebra of currents and the Weinberg spectral-function sum rules, expressions are obtained relating the parameters λ_+, λ_-, and ξ in K_{l3} decays. If one neglects the (0^+) kappa (κ) meson contribution, a comparatively large value of λ_- (an order of magnitude larger than λ_+) is predicted. This is in agreement with the present experimental data. It is also shown that $\xi\lambda_-$ should be small and comparable with λ_+. (auth)

24618 KRONECKER DELTAS IN ANGULAR MOMENTUM FOR WEAK PROCESSES. Gross, David J. (Harvard Univ., Cambridge, Mass.); Pagels, Heinz. Phys. Rev. Lett., 20: 961-3(Apr. 22, 1968).

Kronecker deltas in angular momentum for weak processes are shown to be required by current algebra and conspiracy relations. Theoretical and experimental consequences of such nonanalytic pieces are discussed. (auth)

24619 STRANGE LEPTONS. Beall, E. F. (Univ. of Maryland, College Park). Phys. Rev. Lett., 20: 947-9(Apr. 22, 1968).

Arguments are presented that militate against Weiner's recent proposal that neutral leptonic currents exist, and against the variants of his proposal of strange leptons that involve charged strange leptons. A modified scheme with the addition of only the strange neutrinos, or of only one of them and its antiparticle, is in agreement with the predictions of the Cabibbo theory with the exception of neutrino-induced reactions. (auth)

24620 CURRENTS WITH IRREGULAR CHARGE-CONJUGATION PROPERTIES AND THE NONLEPTONIC HYPERON DECAYS. Herczeg, P. (Univ. of Sussex, Eng.). Nucl. Phys., B4: 153-64(1968).

The nonleptonic hyperon decay amplitudes are investigated under the assumption that the weak hadronic current in the CP-invariant current × current nonleptonic Hamiltonian belongs to an octet representing a mixture of a "regular" and an "irregular" octet with respect to charge-conjugation and that the irregular octet, like the regular one, belongs to the (8,1) representation of $SU(3) \times SU(3)$. The results obtained suggest that the vanishing of the s-wave amplitude $A(\Sigma_2^+)$, for the $\Sigma^+ \to n + \pi^+$ decay may be connected with the presence of irregular currents and independent of the assumption that the $\Delta T = 1/2$ transitions predominate. The relation between reduced matrix elements leading to $A(\Sigma_2^+) = 0$ simultaneously ensures the validity of the $\Delta T = 1/2$ rule in Λ and Σ decays and predicts a violation of this rule for Ξ-decay. (auth)

24621 MUONS. Weissenberg, A. O. New York, John Wiley and Sons, Inc., 1967. 352p. $19.50.

Translated from the Russian by S. Chomet.

Properties of muons, pion decay, negative muon capture, and electromagnetic interactions of muons are discussed. Also considered are mesomolecular phenomena, depolarization of muons, muonium, and cosmic muons. (J.F.P.)

24622 K_{l5} FORM FACTORS FROM PCAC AND CURRENT ALGEBRA AND LEPTONIC WEAK INTERACTIONS OF THE HYPERFRAGMENT, $_{\Lambda}H^4$. McNamee, Peter Charles. Stanford, Calif., Stanford Univ., 1967. 182p.

Thesis.

The form factors for the K_{l5} decay ($K \to \pi\pi\pi l^+\nu_l$) are calculated through the PCAC hypothesis and the SU(3) ⊗ SU(3) algebra of currents. Two methods of calculation are used to obtain the same results: the multiple-soft-pion method, in which all three pions in the final state are taken as zero-frequency (nonphysical) soft pions, and the single-soft-pion method in which each of the three pions in turn is taken as a soft pion and the subsequent set of simultaneous equations relates the K_{l5} decay amplitude to the K_{l4} decay amplitude. The K_{l5} form factors vary quite rapidly in certain soft pion limits due to terms arising from both kaon and pion poles, and may actually be infinite in the limit of two soft pions. The decay rates for the four possible K_{e5} decays are found to be: $\Gamma(K^+ \to \pi^+\pi^0\pi^-e^+\nu_e) = 2.8 \times 10^{-4}$ sec^{-1}, $\Gamma(K^+ \to \pi^0\pi^0\pi^0e^+\nu_e) = 2.7 \times 10^{-4}$ sec^{-1}, $\Gamma(K^0 \to \pi^+\pi^-\pi^-e^+\nu_e) = 8.1 \times 10^{-4}$ sec^{-1}, $\Gamma(K^0 \to \pi^0\pi^0\pi^-e^+\nu_e) = 2.8 \times 10^{-4}$ sec^{-1}. These decay rates are a little larger than those of previous estimates, but even so it is clear that the decays will not be observed in the near future. The leptonic decay of the hyperfragment $_{\Lambda}H^4$ is analyzed. The decay distributions and rates are calculated in impulse approximation for the strangeness-changing $0^+ \to 0^+$ transition $_{\Lambda}H^4 \to He^4 + l^- + \bar{\nu}_l$. Numerical results are given assuming Gaussian wave functions for $_{\Lambda}H^4$ and He^4 and taking the single-particle transition amplitude $\Lambda \to p + l^- + \bar{\nu}_l$ from the Cabibbo hypothesis. The rates for the decays $_{\Lambda}H^4 \to He^4 + e^- + \bar{\nu}_e$ and $_{\Lambda}H^4 \to He^4 + \mu^- + \bar{\nu}_\mu$ are found to be 1.77×10^6 sec^{-1} and 0.548×10^6 sec^{-1}, respectively. In addition to providing a direct measurement of the strangeness-changing vector coupling constant, these processes can be used to investigate the possible existence of an induced scalar (class II) strangeness-changing interaction. The effects of small admixtures of such an induced scalar interaction were calculated to illustrate this point. Finally, it is shown that large corrections to the SU(3) symmetric calculation of the matrix element for $_{\Lambda}H^4 \to He^4 + e^- + \bar{\nu}_e$ are present because of the mixing of SU(3) representation and distortion of the spatial wave functions. The cross section for the weak scattering process $e^- + He^4 \to {}_{\Lambda}H^4 + \nu_e$ is also calculated since it may become measurable with the advent of high flux electron accelerators, the weak interaction being the only means of producing a strange particle below the threshold for associated production. The cross section is calculated from both the impulse approximation and broken SU(3) models assumed above and is $\sim 10^{-41} - 10^{-42}$ cm^2. Finally, an extensive discussion of normalizations and phases in the spherical tensor basis of SU(3) appears in an appendix. (Disser. Abstr.)

Strong (General)

24623 (LPTHE-TH-222) DYNAMICS OF STRONG INTERACTIONS. Omnes, R. (Paris Univ., Orsay (France). Laboratoire de Physique Theorique et Hautes Energies). Oct. 1967. 19p. (CONF-670934-11). Dep.

From International Conference on Elementary Particles, Heidelberg, Germany.

A review of topics on the dynamics of strong interactions is given. This review includes perturbation calculations, the analytic S-matrix, a bound on the $\pi^0\pi^0$ scattering length, Reggeization near t = 0, and bootstrap. Also discussed are finite-energy sum rules, rising trajectories, the bootstrap of rising trajectories, Gribov–Pomeranchuk poles, and cuts. (J.F.P.)

24624 UNIVERSALITY, DEGENERATION OF THE REGGE POLES, AND RATIOS BETWEEN TOTAL CROSS SECTIONS OF HADRON INTERACTION. Rekalo, M. P. (Physical-Technical Inst., Kharkov). Ukr. Fiz. Zh., 12: 2087-9(Dec. 1967). (In Russian).

Ratios between total cross sections for hadronic interactions were analyzed by starting from the proposal that amplitudes for the corresponding elastic processes be entered as terms in the vacuum Pomeranchuk pole, and vector and tensor Regge poles. To determine the terms in the individual Regge poles various combinations of total cross sections were related to one another by using the universal interaction for ρ and ω mesons with hadrons. The principle of the degeneracy of vector and tensor Regge poles was also used. The ratios that were derived could also be obtained in the model of quarks or in the model of Regge poles used in conjunction with SU(3) symmetry. Both models, however, require that all ratios hold equally well. The present analysis indicates that indeed the universal interaction of ρ and ω mesons with hadrons and the degeneracy of ρ and R trajectories lead to results in agreement with experiment. On the other hand, the universality for tensor isosinglets leads to conclusions in disagreement with experimental data. (TTT)

24625 ANALYSIS OF THE UNCORRELATED JET MODEL. Zalewski, Kacper (Inst. of Chemical Physics, Krakow). Nukleonika, 13: 9-21(1968).

A convergence difficulty in the usual derivation of the elastic diffraction peak from the assumption of no correlations in the inelastic final states is pointed out. The difficulty is avoided if the one particle amplitudes are assumed to have momentum dependent phases. (auth)

24626 REMARKS ON THE FIREBALL LIFETIME. Feinberg, Ebgenii L. (Moscow Inst. of Physics). Nukleonika, 13: 1-4 (1968). (In Russian).

The aspects of experimental determination of fireball lifetime are discussed. (tr-auth)

24627 ROLE OF FIREBALLS IN RECENT THEORY OF STRONG INELASTIC INTERACTIONS AT HIGH ENERGY. Chernavskii, Dmutrii S. (Moscow Inst. of Physics). Nukleonika, 13: 5-8(1968). (In Russian).

The problem of fireball production in the framework of the theory of the peripheral interactions is considered. (auth)

24628 EXCITATION OF NEGATIVE PARITY NUCLEON ISOBARS IN THE QUARK MODEL. Clegg, A. B. (Univ. of Lancaster, Eng.). Nucl. Phys., B5: 59-69(1968).

Recent measurements of excitation of higher nucleon isobars in both pp and πp collisions, together with speculations that have been made that their excitation is due to a diffraction dissociation process are discussed. It is shown how this mechanism can be related to recent models ascribing such high energy direct reactions to sums of quark-quark interactions, together with suggested assignments for higher isobars in the quark model: if these assumptions are valid, including the L-excitation assignments to the isobars, the quark-quark diffraction scattering must then include a contribution involving spin-flip. This contribution has some consequences which can be used to check these models and the L = 1 assignments to the negative parity isobars. It is also noted how such a spin-flip contribution could be involved in other processes, including one, production of the A_2 meson, in which its effects may already have been observed. (auth)

24629 SIMPLE METHOD OF PRESENTING JOINT DECAY DISTRIBUTIONS FOR PAIRS OF RESONANCES. Kotanski, A. (Jagellonian Univ., Krakow); Zalewski, K. Nucl. Phys., B4: 559-72(1968).

Statistical tensors are used to describe decay distributions of resonances and joint decay distributions of pairs of resonances. General formulas are derived and their use is illustrated by examples (for ρ, N*, pN*, N*N*, N*$\bar{N}$*). (auth)

24630 INTERFERENCE MODEL AND FINITE ENERGY SUM RULES. Barger, V.; Durand, L. (Univ. of Wisconsin, Madison). Contract AT(11-1)-881. Phys. Lett., 26B: 588-90 (Apr. 1, 1968). (COO-881-158).

The applications of the interference model and finite energy sum rules to intermediate energy hadron scattering are discussed with regard to various limitations of principle and practice. (auth)

24631 GHOST-ELIMINATING MECHANISM AND TRAJECTORY PARAMETER OF A_2 BY PHOTOPRODUCTION SUM RULE. Chu, Shu-yuan; Roy, D. P. (Univ. of California, Riverside). Contract AT(11-1)-34P107A. Phys. Rev. Lett., 20: 958-60 (Apr. 22, 1968).

The A_2 trajectory and residue functions are obtained and are found to change sign around $t = -0.5$ GeV^2. This strongly suggests the Chew or the no-compensation mechanism of ghost elimination. The trajectory parameter $\alpha(t)$ also agrees well with existing estimates. (auth)

24632 CURRENT ALGEBRA AND THE σ-MESON. Ahmed, M. A. (Univ. of Durham, Eng.). Nucl. Phys., B4: 233-43(1968).

Starting from the retarded amplitude involving the commutator of the axial-vector current with a pseudoscalar density a number of sum rules are derived. Saturation of the sum rules with the resonance contribution enables a value to be calculated for the coupling constant to nucleons of the "hypothetical" σ-meson. A relation between the pion-nucleon coupling constant and the πNN* coupling constant is also obtained. (auth)

24633 CONDITIONS ON DENSITY MATRIX ELEMENTS AND THEIR APPLICATION IN RESONANCE PRODUCTION. Daboul, J. (Deutsches Elektronen-Synchrotron, Hamburg). Nucl. Phys., B4: 180-8(1968).

Model-independent upper bounds on the off-diagonal elements of the density matrices were obtained. They follow simply from a geometrical interpretation of these quantities. (auth)

24634 PRACTICAL POINTS CONCERNING THE SOLUTION OF THE SCHROEDINGER EQUATION. Blatt, John M. (Hebrew Univ., Jerusalem. Weizmann Inst., Rehovoth, Israel). J. Comput. Phys. 1: 382-96(Feb. 1967).

The numerical solution of the one-dimensional Schrödinger equation in a potential of the type occurring in molecular spectroscopy is considered i.e., with both an inner and an outer classical turning point. Some practical tricks are described which, it is hoped, may prove useful. These involve choice of a step size, changing step size, iteration on the eigenvalue, setting upper and lower bounds on the eigenvalue, determining a useful range of x for the integration, etc. Formulas are derived for the value of the function, and of the first derivative, to be used in conjunction with the Noumerov method. (auth)

24635 BOOTSTRAP THEORY AND CERTAIN PROPERTIES OF THE HADRON AXIAL VECTOR CURRENT. Chapline, George Frederick Jr. Pasadena, Calif., California Inst. of Tech., 1967. 53p.

Thesis.

The matrix element $\langle\Omega^-|j_\mu^A|\Xi^0\rangle$ is calculated. A similar calculation for $\langle\Delta|j_\mu^A|N\rangle$ is compared with experiment. The relation of the Goldberger-Treiman relation to the bootstrap principle is discussed. Approximate symmetry predictions for the axial vector current are compared with the S-matrix calculations. Implications of the bootstrap principle for equal time commutators of hadron currents are discussed. (Disser. Abstr.)

Strong (Baryon No. = 0)

24636 (COO-881-87) ON LOW ENERGY π-π SCATTERING. Olsson, Martin G. (Wisconsin Univ., Madison). Oct. 1966. Contract AT(11-1)-881. 13p. Dept. CFSTI.

Using a sum rule the p-wave π-π scattering length a_1 is found to be $a_1 = 0.038 \pm 0.005$. It it is assumed that the invariant π-π amplitude interpolates linearly in s, t, and u below threshold, then the s-wave scattering lengths can be calculated giving $a_0 = 0.45 \pm 0.1$ and $a_2 = 0.1 \pm 0.04$. A broad I = 0 s-wave resonance is predicted. (auth)

24637 MULTIPION PRODUCTION IN $\bar{p}p$ ANNIHILATION AND COMPARISON WITH EXPERIMENTAL DATA. Fridman, A.; Maurer, G.; Strub, R. (Centre de Recherches Nucleaires, Strasbourg). Z. Phys., 211: 250-6(1968).

By taking the available data on $\bar{p}p$ annihilation into pions, it was seen that the branching ratio for different charge configurations in the final state are determined by statistical factors. The total calculated $\bar{p}p$ annihilation cross sections derived from this rule and the knowledge of the cross section for the fitted channels are in good agreement with the experimental values. A systematic variation of forward peaking of the outgoing pions in the cm was seen. This can be partly explained by a cloud-core model for the nucleon and antinucleon interaction. (auth)

24638 CALCULATIONS USING THE DISPERSION RELATIONS FOR FORWARD K^+p SCATTERING. Perrin, R. (Univ. of Durham, Eng.); Woolcock, W. S. Nucl. Phys., B4: 671-81(1968).

Using the dispersion relations for the K^+p forward elastic scattering amplitudes, it is found that the combination of coupling constants $(g^2_{K^-pA} + 0.847\, g^2_{K^-p\Sigma^0})$ is 155 ± 35. This result is compatible with the assumption of SU(3) invariance for the meson-baryon coupling constants. (auth)

24639 CHIRAL ALGEBRA, MESON DOMINANCE, AND THE SOFT-PION EVALUATION OF g_ρ. Arnowitt, R.; Friedman, M. H.; Nath, P. (Northeastern Univ., Boston). Nucl. Phys., B5: 115-18 (1968).

The derivations of $g_\rho^2 = 2F_\pi^2 m_\pi^2$ by Kawarabayashi and Suzuki and others are re-examined. It is shown that when the full content of chiral algebra is exploited, the analysis reduces to an identity rather than a determination of g_ρ. (auth)

24640 PARTIAL-WAVE ANALYSIS AND OPTICAL MODEL FOR $\bar{p}$-p SCATTERING. Marcelja, F. (Univ. of Zagreb). J. Phys., A, 1: 295-6(Mar. 1968).

The partial-wave analysis of the $\bar{p}$-p scattering amplitude in the energy region 50 to 180 MeV was performed and the results compared with those of the optical model. (auth)

24641 IMPLICATIONS OF ISOSPIN DEPENDENCE OF $N\bar{N}$ ANNIHILATION CROSS SECTIONS. Barger, V.; Cline, D. (Univ. of Wisconsin, Madison). Contract AT(11-1)-881. Phys. Lett., 26B: 591-4(Apr. 1, 1968). (COO-881-156).

The observed isospin independence of hadron elastic scattering amplitudes is shown to impose strong constraints on the isospin dependence of inelastic channels. Possible ways in which these constraints may be experimentally realized are discussed. Meson exchange sum rules are also shown to imply relations between certain meson exchange and baryon exchange inelastic processes. (auth)

24642 $\bar{p}p$ ANNIHILATION INTO PIONS. Herbert, Jacques; Mes, Hans (Univ. of Ottawa). Nucl. Phys., B4: 244-8(1968).

The conservation of isospin is applied in a statistical manner to $\bar{p}p$ annihilation at rest. From six experimentally known pionic decay modes, twelve others were calculated. The calculated and experimental average pion multiplicities and charged pion frequencies are compared. Agreement is obtained when the $\bar{p}p$ annihilation system is initially in a pure $|T = 1, T_3 = 0\rangle$ state or for an equal mixing of $|10\rangle$ and $|00\rangle$ states, if the $|10\rangle$ state proceeds directly to a $|00\rangle$ state following π emission. These results also agree with a Fermi-statistical model having $\Omega = 8\Omega_0$. (auth)

24643 $A_1 \to \rho\pi$ AND $\rho \to 2\pi$ DECAYS AND $\pi^\pm$–π^0 MASS DIFFERENCE. Fayyazuddin (Univ. of Chicago); Riazuddin. Contract AT(11-1)-264. Nuovo Cim., 54A: 520-8(Mar. 21, 1968). (COO-264-410).

An attempt is made to find a connection between various approaches used in the study of $A_1 \to \rho\pi$ and $\rho \to 2\pi$ decays, and to correlate these decays with the $\pi^\pm$–π^0 mass differences. (L.B.S.)

24644 THIRD DOUBLE-SPECTRAL FUNCTION EFFECTS. Schwarz, J. H. (Princeton Univ., N. J.). Nuovo Cim., 54A: 529-31(Mar. 21, 1968).

The importance of third double-spectral function effects for Gribov-Pomeranchuk poles in two-particle scattering amplitudes is examined for the $\omega + \pi \to \pi + \pi$ interaction. (L.B.S.)

24645 VARIATIONAL SOLUTIONS SATISFYING HYPERVIRIAL THEOREMS IN FIXED-SOURCE BOSON THEORIES. McArthur, Donald Eugene. Lincoln, Neb., Univ. of Nebraska, 1967. 70p.

Thesis.

The Tomonaga intermediate coupling approximation for fixed-source boson theories is examined, and a necessary condition for its validity is given. Additional variational flexibility is introduced in such a way that a set of hypervirial theorems is automatically satisfied for the optimum choice of parameters. A procedure is given which allows the optimization to be carried out easily for the hypervirial theorems considered. It is well known that certain exact relations which are derivable from hypervirial theorems do not hold when the Tomonaga method is applied to fixed-source pseudoscalar meson theory. It is possible to modify the Tomonaga method in such a way that these exact relations are satisfied and the resulting reduced equation is not changed in form. The functional form of a modified ground-state eigenfunction which satisfies these relations is given. A 0.2% improvement in the energy is found when it is calculated using the solution of the reduced equation given by Friedman, Lee, and Christian. Nearly all of this shift in energy is due to the fact that the reduced equation was not solved accurately. A problem for which the Tomonaga method can be carried out numerically with no further approximation is considered in detail. It is found that the introduction of additional variational flexibility results in a very small improvement in estimate of the ground-state energy and a small change in the eigenfunction although all of the variational parameters are redetermined. While the numerical values of the matrix elements of many operators are slightly altered, there are qualitative features of the eigenfunction which show a significant change. The bosons become correlated while they are uncorrelated in the Tomonaga approximation. This feature remains in the strong-coupling limit and is a direct consequence of the internal degrees of freedom of the source. In the strong-coupling limit, the reduced equation becomes the Schrödinger equation for a harmonic oscillator with a hard core. The ground-state eigenfunction for this problem is expressed in terms of simple integrals related to gamma functions and is used to calculate the energy. (Disser. Abstr.)

24646 PARTIAL WAVE BOOTSTRAP CALCULATION FOR ELASTIC PION–PION SCATTERING. Kyle, Charles Franklin. Stanford, Calif., Stanford Univ., 1967. 98p.

Thesis.

An equation is derived which expresses crossing symmetry in terms of partial wave quantities. The equation involves a sum over partial waves which converges inside a usable part of the physical region and has the properties that the correct threshold behavior for the partial wave amplitudes is automatic. The driving forces show no high energy divergence if one stays inside the region of convergence of the partial wave summation. Coupled with the N/D equations for unitarity in the partial waves this equation forms the basis for a solution to the pion-pion bootstrap problem

within the framework of S-matrix theory. Using an approximate solution to the N/D equations developed by H. R. Pagels, a numerical calculation is performed and it is found that one does indeed have convergence of the partial wave sum in the crossing equations. Higher partial waves, particularly D- and F-waves are found significant to the nature of the solutions obtained. Difficulties which are credited to inelastic effects arise when one tries to extend the results to higher energies. The S-waves present problems, both amplitudes generally displaying bound states, but one finds evidence that there should be solutions for which the isospin two S-wave is not bound and the bound state pole for isospin zero may belong at negative values of the energy squared according to the conjecture of Chew. A solution yielding a ρ meson with the physically observed mass and a width of about 200 MeV is found along with an f_0 with about half the physical mass. Chew and Frautschi have conjectured that the strong interactions should be characterized by having couplings as strong as is consistent with unitarity. It is found that the best ρ is produced for values of the amplitudes at threshold quite near the largest values at which solutions are found in agreement with this conjecture. However, these results are not to be heavily emphasized in view of the problems with the S-waves which remain. (Disser. Abstr.)

24647 STATISTICAL MODEL FOR PARTICLE PRODUCTION IN ANTIPROTON–PROTON ANNIHILATIONS AT REST. Matlock, Rex Leon. Baton Rouge, La., Louisiana State Univ., 1967. 50p.

Thesis.

A statistical model for antiproton-proton annihilations at rest is developed. The formalism used allows the particle number and momentum distributions, for the particles produced by the annihilation, to be calculated in a simple way. These calculated distributions are found to compare well with experimental observation. The value of the radius of the interaction volume needed to fit the model to experimental observation (including the K-meson production rate) is found to be about 2 pion Compton wave lengths, a value within the bounds of expectation for the model. (Disser. Abstr.)

Strong (Baryon No. = 1)

Refer also to abstracts 24571, 24582, 24599, and 24683.

24648 (DESY-68/2) LADDER APPROXIMATION IN PARTIAL WAVE DISPERSION RELATIONS. Gutbrod, F. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Jan. 1968. 17p. Dep.

The lefthand cut of the $^3/_2$, $^3/_2$ π-N partial wave amplitude is calculated by iterating the Bethe–Salpeter equation with nucleon exchange including a smooth cutoff. The partial wave dispersion relation is approximately satisfied, if the cutoff is chosen properly. The magnetic dipole excitation of the isobar as well as the transition form factor are determined through a dispersion sum rule retaining only a class of ladder diagrams. (auth)

24649 (LA-DC-8107) SELF-CONSISTENT ONE-BARYON STATE IN A FIELD THEORY. Bolsterli, M. (Minnesota Univ., Minneapolis. School of Physics. Los Alamos Scientific Lab., N. Mex.). [1966]. Contract W-7405-eng-36. 9p. Dep. CFSTI.

A self-consistent state which factors into meson and baryon parts is proposed as a one-baryon state in strong-coupling scalar theory with recoil. (auth)

24650 INFINITE REGGE RECURRENCES AND HIGH-MOMENTUM-TRANSFER INELASTIC πp COLLISIONS. Bialas, Andrzej (Jagellonian Univ., Krakow. Inst. of Nuclear Physics, Krakow); Czyzewski, Oleg. Nukleonika, 13: 37-40(1968).

The influence of the resonance formation on the high-momentum transfer inelastic πp collisions is discussed on the basis of the model with infinite Regge recurrences, proposed earlier. (auth)

24651 $\gamma 3\pi$ INTERACTION AND RADIATION πN SCATTERING. Radutskii, G. M.; Serdyutskii, V. A.; Tabachenko, A. N. Yadern. Fiz., 7: 405-4(Feb. 1968). (In Russian).

The role of the $\gamma 3\pi$ vertex and of the final-state interaction in the reaction $\pi^- + p \rightarrow \pi^- + p + \gamma$ is studied. It is shown that the role of the final-state interaction is negligible. This confirms the possibility of measuring the effective constant of the $\gamma 3\pi$ interaction using only diagram with one-pion exchange as a dominating mechanism of the reaction under investigation. (auth)

24652 SUITABLE MEASUREMENT METHOD OF THE SPIN FLIP EFFECT IN THE MESON–NUCLEON SCATTERING. Levintov, I. I.; Ryndin, R. M. (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz., 7: 413-17(Feb. 1968). (In Russian).

Experiments on the investigation of the spin flip effect when the target polarization is directed along the recoil nucleon momentum (or comprises with this momentum an angle equaled in its value to the kinematic spin-flip angle at the scattering) are considered. The parameter measured contains naturally the same information as the usual parameters A and R, but is more convenient both from the experimental and the theoretical point of view. (auth)

24653 POMERANCHON SU(3) ASSIGNMENT AND TOTAL CROSS SECTIONS. Davier, M. (Stanford Univ., Calif.). Contract AT(04-3)-515. Phys. Rev. Lett., 20: 952-4(Apr. 22, 1968). (SLAC-PUB-385).

In the discussion of the Pomeranchon SU(3) assignment for πN and KN interactions, SU(3) is assumed to be an exact symmetry for scattering amplitudes even at energies of 10 to 20 GeV. The high-energy behavior is given by exchanges in the t-channel, the main contribution coming from the Pomeranchon of which the SU(3) assignment is determined. The results of the Regge pole fits are given. (auth)

24654 MULTIPLE-SCATTERING CORRECTIONS TO THE JOHNSON–TREIMAN RELATION IN THE QUARK MODEL. Dean, Nathan W. (CERN, Geneva). Nucl. Phys., B4: 534-8(1968).

The Glauber formalism for multiple scattering is applied to meson-nucleon interactions, using a quark model for the mesons. Assuming only that the quark-nucleon interactions maintain isosymmetry, an equation is found relating the Johnson-Treiman sum of amplitudes to correction terms arising from double-scattering effects. The correction terms turn out to be very small, consistent with the excellent agreement of the Johnson-Treiman relation with experiment. (auth)

24655 SU(3) SYMMETRY AND REGGE POLES AT HIGH ENERGY. Derem, A. (CEN, Saclay, France). Nucl. Phys., B5: 70-4(1968).

In the framework of the Regge-pole theory, various authors have given predictions concerning the differential cross section of the charge-exchange scattering $K^+ + n \rightarrow K^0 + p$ at high energy, making use of the measured differential cross sections for the processes $\pi^- + p \rightarrow \pi^0 + n$, $\pi^- + p \rightarrow \eta^0 + n$ and $K^- + p \rightarrow \bar{K}^0 + n$. Here it is shown that one cannot be sure whether Regge-pole theory is being tested, or simply SU(3) symmetry. Another relation is given between the same differential cross sections, which is more closely related to the Regge-pole behavior. (auth)

24656 HELICITY FORMALISM AND THE SUPERCONVERGENT SUM-RULES FOR THE PROCESS $N^* + \pi \rightarrow N + \rho$. Miah, M. A. W. (Univ. of Durham, Eng.). Nucl. Phys., B5: 109-14 (1968).

In order to obtain the superconvergent sum rules the process $\pi N^* \rightarrow \rho N$ is considered. Contrary to the results obtained by Jones and Scadron, the results derived from the sum rules show little agreement with those predicted by the U(6,6) theory. (auth)

24657 ASYMPTOTIC SU(3) SYMMETRY, CABIBBO ANGLES, AND SUM RULES FOR THE CONSTANTS OF COUPLING BETWEEN PSEUDOSCALAR MESONS AND BARYONS. Gerasimov, S. B. JETP Lett. (USSR)(Engl. Transl.), 7: 30-2(Jan. 15, 1968).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 7: 41-3(Jan. 15, 1968).

Dispersion sum rules for vertex functions are discussed, which were derived under the following assumptions: the consequences that follow from unbroken SU(3) symmetry are satisfied for the vertex form factors in the asymptotic region of large momentum transfers; and the dispersion integrals are saturated by the contribution of the nearest poles in the t-channel. Using values of meson-baryon coupling constants previously determined from dispersion relations for KN scattering, an upper and lower limit was obtained for Sin θ_w. (L.B.S.)

24658 STUDY OF ANGULAR DECAY CORRELATIONS FOR THE PROCESS $\pi + N \rightarrow \rho + N^*$ IN THE REGGE-POLE MODEL. I. Bender, I.; Linke, V.; Rothe, H. J. (Univ., Heidelberg). Nuovo Cim., 54A: 407-26(Mar. 21, 1968).

A theoretical model is presented to describe the angular correlations and differential cross section for the reaction $\pi + N \rightarrow \rho + N^*$, where the ρ and N^* decay into two pions, and into pion + nucleon, respectively. For the production mechanism a Regge-pole model is assumed involving the exchange of the π and A_2 trajectories; while the A_2 is fully Reggeized, arguments are presented in favor of treating the pion essentially as elementary. Assuming that the t-dependence of the residue functions is given by the kinematic singularities and zeros, together with an exponential behavior which is independent of the helicities, the number of parameters required can be reduced to seven. For the purpose of the experimental analysis a list of projection functions is given, with the help of which the various coefficients multiplying the angular functions describing the decay distribution may be obtained. (auth)

24659 REGGEIZATION OF INVARIANT AMPLITUDES. Jones, H. F.; Scadron, M. D. (Imperial Coll. of Science and Tech., London). Nucl. Phys., B4: 267-76(1968).

A return to a method of Reggeizing invariant amplitudes now made feasible by virtue of recent advances in the technique of high-spin propagators is proposed. The advantage of this method over the usual method of Reggeizing helicity amplitudes is that only the invariant amplitudes are required to be finite at t = 0 in order that the complicated conditions on helicity amplitudes there be satisfied: this is achieved by using a dispersion relation to continue the Regge amplitude below threshold. The possible existence of "daughter" trajectories and applications to superconvergence are discussed. (auth)

24660 ON THE S-MATRIX OF HIGHLY ABSORPTIVE RESONANT WAVES: THE πN S_{31} WAVE. Ranada, A. F. (Junta de Energia Nuclear, Madrid). Nuovo Cim., 54A: 234-42 (Mar. 21, 1968).

It is shown that the S-matrix of a highly absorptive resonant wave is dominated by a factor called outer factor. As an application an analytic expression for πN S-matrix in S_{31} wave is found. (auth)

24661 STUDY OF ANGULAR DECAY CORRELATIONS FOR THE PROCESS $\pi + N \rightarrow \rho + N^*$ IN THE REGGE-POLE MODEL. II. Bender, I.; Brandt, S.; Linke, V.; Rothe, H. J. (Univ., Heidelberg). Nuovo Cim., 54A: 487-90(Mar. 21, 1968).

A model previously constructed (Bender, et al., Nuovo Cimento, 54A: 407(1968)) to describe the angular correlation in the decay of the ρ and N^* produced simultaneously in a π-N collision is applied to the case where the resonances are produced at a lab energy of 8 GeV. (L.B.S.)

24662 AN ATTEMPT TO DETERMINE VAN HOVE'S OVERLAP FUNCTION AND SHADOW ELASTIC SCATTERING FROM THE MEASUREMENTS OF INELASTIC π^+p INTERACTIONS AT 8 GeV/c. Michejda, L. (Inst. of Nuclear Research, Warsaw). Nucl. Phys., B4: 113-30(1968).

From the measurements of π^+p inelastic reactions at 8 GeV/c the Van Hove overlap function is determined assuming no correlations among secondary particles, a constant phase of the wave function and neglecting spins. The overlap functions obtained for various channels are used to compare how much "peripheral" or "central" these collisions are. It was found that the computed overall function violates unitarity bounds on partial inelastic cross sections $\sigma|_{in}$ and is in a striking disagreement with the $\sigma|_{in}$ estimated from the analysis of the elastic differential cross section. It seems that the failure of the calculation is mainly due to the incorrect assumption that the phase of the many-body wave function does not depend on the momentum configuration of the final-state particles. (auth)

24663 APPLICATION OF THE IMPACT PARAMETER FORMALISM TO π-p ELASTIC SCATTERING AT HIGH ENERGY. Musette, M. (Univ. Libre, Brussels). Nucl. Phys., B4: 131-46 (1968). (In French).

The impact parameter development of the spin-0–spin-$\frac{1}{2}$ elastic amplitude is related to the usual development in Legendre functions. This formalism is applied to the study of the high-energy π-p elastic collision. (auth)

24664 ON THE ORIGIN OF THE πK^* ENHANCEMENT. Zhizhin, E. D. (Univ. of Birmingham, Eng.). Nucl. Phys., B4: 413-16(1968).

The origin of the enhancement in the mass distribution of the πK^* system arising from the dissociation $K^- \rightarrow K^* + \pi$ on protons is discussed. The peripheral model represents the shape of the distribution rather well. To obtain correct values of the cross section, more accurate analysis of the πN resonance region is necessary. Some specific features of the process of diffraction dissociation on a nucleus at high energies are considered. (auth)

24665 PRODUCTION OF PIONS BY PROTONS ON NUCLEI AND NUCLEAR SHAPE. Margolis, B. (CERN, Geneva). Nucl. Phys., B4: 433-8(1968).

An isobar model for the production of pions by 600 MeV protons on nuclei is studied. The higher-energy pions are predicted to come from incoherent nucleon-nucleon production of the (3,3) isobar in the nuclear surface. Considerable sensitivity of the production to the nuclear surface properties is found. Agreement is found with nuclear surface properties determined by multi-GeV incoherent quasi-elastic scattering of nucleons by nuclei. The results here can be easily generalized for neutron projectiles. It is possible that the incoherent production model studied here will be useful in determining high-energy unstable particle-nucleon total cross sections. (auth)

24666 REGGE-POLE MODEL FOR ISOSPIN-3/2 SPDF PION–NUCLEON PARTIAL-WAVE AMPLITUDES. Meng, Ta-chung; Strauss, R.; Wunder, H. (Univ., Karlsruhe, Ger.). Nucl. Phys., B4: 425-31(1968).

The direct channel Δ Regge-pole model is extended by writing the usual Regge ansatz for the πN amplitudes in terms of a Khuri-type representation proposed by Kretzschmar. A general, explicit expression for all isospin-$\frac{3}{2}$ partial-wave amplitudes is derived from this ansatz. This expression for $f^{\frac{3}{2}}_{l,\pm}$ turns out to have certain desirable features including reasonable analyticity properties and correct threshold behaviour for the real and imaginary parts of all partial waves. By using the usual simple assumptions about the Regge parameters, the SPDF waves are calculated and compared with several recent phase shift analyses. (auth)

24667 THE COMPARISON OF K^+p and K^+n DISPERSION RELATIONS WITH EXPERIMENT. Martin, A. D.; Poole, F. (Univ. of Durham, Eng.). Nucl. Phys., B4: 467-78(1968).

An unsubtracted dispersion relation is introduced and is used to predict the real parts of the K^+p and K^+n forward scattering amplitudes as a function of energy. These predictions are found to be in good agreement with experiment. (auth)

24668 APPLICATIONS OF THE ABSORPTIVE ONE PION EXCHANGE MODEL. Gordon, Robert David. Waltham, Mass., Brandeis Univ., 1967. 110p.

Thesis.

The one pion exchange model, corrected for absorption in the initial and final states is derived and examined for two body reactions involving the production of low and high spin particles. It has been observed that the standard formulation of the model overestimates the reaction cross section for high spin final states by a factor of approximately two. It is found that the inclusion of a non-rapidly varying form factor brings theory into agreement with experiment for a number of reactions involving high spin final states. Here the specific reaction studied is f^0 meson production by pions off nucleons. The model is next applied to the production of the recently reported S^* meson by pions off nucleons to determine coupling constants with the subsequent attempt to set up a new multiplet. Because of the low spin of the S^* meson (S = 0) the standard formulation of the model has been used. The $K\bar{K}$ and $\pi\pi$ partial widths for the S^* meson are obtained. The value for these partial widths is found to be consistent with SU(3) calculations involving a nonet of scalar mesons. Reaction cross sections for some of these mesons are calculated by means of the absorption model. An isospin 1, hypercharge zero scalar meson called the π' is predicted at mass of ~600 MeV. Finally the absorption model is compared to the Regge theory. It is shown that the most distinctive difference between the two theories is the predicted high energy behavior of the reaction cross section. Differences in the predicted decay distributions are also discussed. (Disser. Abstr.)

24669 ANALYTICITY AND UNITARITY IN A MODEL S-MATRIX THEORY. Chen, Fong-ching. Waltham, Mass., Brandeis Univ., 1967. 124p.

Thesis.

A model of S-matrix theory (the "Extended One-Pion Exchange" or EOPE model) such as has been considered by Grisaru is studied in the N/D formulation, with particular emphasis on the origin and effects of a certain nonunitary right-hand cut (Ω) in the partial energy variables of the S-wave multiparticle amplitude $\pi\pi N \rightarrow \pi\pi N$. The manner in which Ω is generated through partial wave projection by a pinch of the cos θ contour is analysed. The usual extended unitarity equations connected with the physical cut (the 2'-cut) in the total energy variable which is generated by a resonance or bound-state pole in the partial energy variable are derived without extra assumptions in a model in which the left- and right-hand cuts of the amplitudes are separable. These equations are shown to be modified by the presence of Ω in the EOPE model. It is verified that the 2'-cut disappears through the three-particle threshold as expected in the first model. This does not happen, however, in the EOPE model if the 2'-cut is generated by a bound-state pole. The meaning of this is discussed. N/D equations are derived similar to those of Ball, Frazer and Nanenberg but with additional terms introduced by Ω. A very crude solution similar to that of Cook and Lee is studied, which shows that Ω can have effects at least as important as the input "dynamic singularities" of the model when the $\pi\pi$ amplitude is dominated by a resonance with a width comparable to that of the ρ-meson. (Disser. Abstr.)

24670 PION PRODUCTION AND PION–NUCLEON SCATTERING. Nath, Nitya Ranjan. Ithaca, N. Y., Cornell Univ., 1967. 233p.

Thesis.

A systematic study is made of the effect of production reactions ($\pi N \rightarrow \rho N$, and $\pi N \rightarrow \pi N^*$) on elastic pion-nucleon scattering. The basis of this work which, in its core, is concerned with unitariza-

tion of long-range, inelastic Born graphs, is to be found in the works of Cook and Lee, Phys. Rev. 127: 283, 297 (1962). Both one-pion-exchange in the reaction $\pi N \rightleftharpoons \rho N$ and nucleon-exchange in the reaction $\pi N \rightleftharpoons \pi N^*$ as were included as "inputs," and the instability of ρ and N^* was more seriously. Multi-channel unitarity (Blankenbecler's version), comprising all amplitudes which connect πN, ρN and πN^* states, was imposed and is rigorously satisfied by the solutions. The problem is formulated in terms of the usual ND^{-1} decomposition. An attempt has been made to incorporate the two-sheeted, "anomalous" structure of the partial-wave Born singularities. The final solution for the unitarized amplitude is obtained in an implicit algebraic form. A serious difficulty seems to issue from this study: The unitarized solution, it appears, is not manifestly hermitean-analytic. The calculations that are required for obtaining the partial-wave Born amplitudes are presented in detail; a brief survey of the technicalities of partial-wave decomposition has also been included. Approximate numerical solutions, which are obtained by replacing the anomalous singularity structure with a normal structure, are given. (Disser. Abstr.)

24671 RENORMALIZATION OF THE SCATTERING THEORY OF PIONS AND NUCLEONS. Johnson, Rodney Wayne. Stanford, Calif., Stanford Univ., 1967. 120p.

Thesis.

The Dyson-Salam approach to renormalization is applied to the $\lambda\phi^4$ meson scattering theory and to the pseudoscalar pion-nucleon theory. Starting from the unrenormalized perturbation series, a formal derivation and justification of the renormalized perturbation series is given by detailed analysis of sets of Feynman graphs. It is verified by Weinberg's theorem that the renormalized series are indeed given by convergent integrals to any finite order in perturbation theory. (Disser. Abstr.)

24672 PCAC AND THE STRONG INTERACTIONS. Scanio, Joseph John George. Berkeley, Calif., Univ. of California, 1967. 75p.

Thesis.

A consistency condition on the strong interaction isospin symmetric pion-nucleon amplitude has recently been derived using the hypothesis of a partially conserved weak axial-vector current (PCAC) for the hadrons. A detailed discussion and an accurate evaluation of the consistency condition are given in an attempt to understand how significantly the PCAC hypothesis affects the strong interactions. The method of evaluation consists of an extrapolation of the pion-nucleon amplitude at constant scattering angle from the physical region where it can be evaluated experimentally to the unphysical point where the consistency condition is believed to hold, the consistency point. The extrapolation procedure is justified by an examination of the first and second sheet singularities of the amplitude. It is found that the consistency condition is very well satisfied. However, one must use a sum rule derivable from crossing in the numerical calculation to avoid the use of the experimentally poorly determined isospin one-half S-wave phase shift. Some suggestions are given as to the probable variation of this phase shift in the low-energy region. It would be interesting to check this experimentally. Also an accurate determination of the P' Regge trajectory intercept is given, using a dispersion relation sum rule for the forward pion-nucleon amplitude. The results of this calculation are used to evaluate a constant appearing in current commutator discussions of the consistency condition. The results give support to the choice of the consistency point. The method of evaluation is also applied to other reactions which admit a consistency condition. (Disser. Abstr.)

24673 PHYSICAL INTERPRETATION OF STATIC MODEL PARAMETERS. Markley, Francis Landis Jr. Berkeley, Calif., Univ. of California, 1967. 58p.

Thesis.

It is shown that an approximation to the static crossing matrix leads to a soluble model for the p_{11} and p_{33} πN scattering amplitudes in which the parameters are related to forces due to particle exchanges in the t-channel. Reasonable values of these forces give the nucleon bound state and the Δ resonance in good agreement with experiment. Further properties of the model are investigated. (Disser. Abstr.)

24674 RESONANCES AND KINEMATICAL PEAKS IN STRONG INTERACTIONS. Kramer, Ivan. Berkeley, Calif., Univ. of California, 1967. 130p.

Thesis.

Two peripheral models involving pion-nucleon reactors leading to a four-body final state are studied with particular respect to the predictions of the models for various three-particle invariant mass distributions. These predictions are compared in detail to experimental results. The peaks in the mass distributions produced by the models, being accidents of the phase space, cannot be associated with true resonances. The first model considered assumes a double two-particle resonance intermediate state. The second model contains one two-particle resonance and one virtual nucleon and is used in fitting diffraction scattering data. The entire formalism contained herein assumes arbitrary values for the center of mass energy and all masses involved. Thus, the results can easily be applied to a variety of different reactions at a variety of different energies. (Disser. Abstr.)

24675 π–N SCATTERING AT HIGH ENERGIES: SPIN DEPENDENCES IN THE FORWARD DIRECTION AND REGGE POLES IN THE BACKWARD DIRECTION. Paschos, Emmanuel Anthony. Ithaca, N. Y., Cornell Univ., 1967. 107p.

Thesis.

A critical investigation of the interpretation of the data in the Coulomb interference region, together with a numerical verification of the Khuri-Kinoshita sum rules is presented. The validity of Regge poles in the scattering of two unequal mass particles in the backward direction is also given. A new Regge representation is introduced involving Legendre's functions of a modified argument. All of these results are compatible with the results of other investigations. In addition, the pion-nucleon case is discussed explicitly including Gribov's theorem on fermion Regge poles and several other attractive features of the formalism. The analysis is done in terms of helicity amplitudes and its generalization to higher spin configurations is straightforward. (Disser. Abstr.)

Strong (Baryon No. ≥ 2)

Refer also to abstract 24596.

24676 (LA-DC-8138) NUMERICAL EVALUATION OF SEPARABLE POTENTIALS FOR THE SINGLET (J = 0) AND TRIPLET (J = 1) PARTIAL WAVES OF THE NUCLEON–NUCLEON SYSTEM. MacKenzie, James J. (Minnesota Univ., Minneapolis. School of Physics. Los Alamos Scientific Lab., N. Mex.). [1966]. Contract W-7405-eng-36. 30p. Dep. CFSTI.

The results of numerical calculations for separable potentials which will fit the singlet (J = 0) and triplet (J = 1) partial waves of the nucleon–nucleon system are presented. Although no unique set of potentials was found, it is shown that the principal differences in the solutions are at high energies. The deuteron wave function and its quadrupole moment and D state probability are also presented for several mixing parameters. (auth)

24677 AZIMUTHAL ANGULAR DISTRIBUTIONS OF SECONDARIES FROM INTERACTIONS OF COSMIC RAY PARTICLES WITH EMULSION NUCLEI. Czachowska, Zofia; Jurak, Alina; Linscheid, Anna (Inst. of Nuclear Research, Krakow). Nukleonika, 13: 55-60(1968).

Azimuthal angular distributions of 65 events of interactions of cosmic ray particles with emulsion nuclei were studied from the viewpoint of noncolinear emission of fireballs. Significant deviation from isotropic distribution of azimuthal angles was found in the group of events with $\gamma_c \leq 20$ (where γ_c is the Castagnolii estimate of the Lorentz factor of the CM-system). No such deviation was found for events with $\gamma_c > 20$. (auth)

24678 POSSIBLE METHOD TO DISCRIMINATE STATISTICAL HYPOTHESES AT CLOSE VALUES OF χ^2 AND ITS APPLICATION TO THE PHASE SHIFT ANALYSIS OF NUCLEON–NUCLEON SCATTERING. Kazarinov, Yu. M.; Kiselev, V. S.; Rozanova, A. M.; Silin, I. N. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 7: 340-8(Feb. 1968). (In Russian).

A method to estimate the probability of the first class error P is proposed when rejecting one of the hypotheses with the account of the correlation of its χ^2 with the χ^2 value of the best of the hypotheses. The method is reasonable for application in the case when one of the hypotheses cannot be rejected using the conventional χ^2 criterion. The estimate of P was used to discriminate solutions in the phase shift analysis of nucleon–nucleon scattering at 630 MeV. (auth)

24679 SATURATION OF THE SUM RULES FOLLOWING FROM THE CURRENT ALGEBRA AND THE ROLE OF THE SCHWINGER TERMS. Sokolov, V. V.; Khriplovich, I. B. Yadern. Fiz., 7: 405-12(Feb. 1968). (In Russian).

The relations obtained when saturating the sum rules following from the current algebra by intermediate one-nucleon and isobar states are considered. It is shown that in this approximation there is no "dressing" of the nucleon vertex as well as no nucleon-isobar transition. It is also shown that previous results are incorrect as the intermediate states like $2N\bar{N}$ are not taken into account in them. General expressions for the Schwinger terms in the quark model are given. It is shown that their contribution is some cases is identically zero. (auth)

24680 PARITY-VIOLATING NUCLEON–NUCLEON POTENTIAL. Lacaze, R. (Centro Brasiliero de Pesquisas Fisicas, Rio de Janeiro). Nucl. Phys., B4: 657-70(1968).

A static parity-violating nucleon-nucleon potential due to the two-pion exchange is constructed, assuming the current-current and CVC hypotheses for weak interactions. Rescattering terms as well as the $\pi\pi$ P-wave in the strong π-N vertex are taken into account. The results differ from those obtained by Blin-Stoyle in a perturbation calculation for the strong interaction; namely, the range of our potentials is longer and this might modify Partovi's results for the asymmetry coefficients in photodisintegration of the deuteron. (auth)

24681 SIMULTANEOUS PHASE SHIFT ANALYSIS OF 210 MeV NUCLEON–NUCLEON SCATTERING. Janout, Z.; Kazarinov, Yu. M.; Lehar, F.; Winternitz, P. (Joint Inst. for Nuclear Research, Dubna, USSR). Nucl. Phys., B4: 527-33(1968).

Phase-shift analysis at 210 MeV was performed taking $l_{max} = 5$. New data on the differential cross section, polarization and triple scattering parameters were used and the procedure leads to a unique solution. The angular dependences of experimental quantities are shown in diagrams. (auth)

24682 LAMBDA–NUCLEON SCATTERING. Deloff, A. (Rutherford High Energy Lab., Chilton, Eng. Inst. for Nuclear Research, Warsaw). Nucl. Phys., B4: 585-97(1968).

A one-boson-exchange (OBE) model of baryon-baryon interaction is developed. The forces are assumed to be generated by the exchange of 0^-, 1^- octets and a tentatively assumed 0^+ octet simulating two-boson-exchange effects. To obtain the relevant coupling constants and masses of 0^+ particles the Hamada-Johnston N-N potential is fitted by OBE potential. This, together with SU(3) symmetry assumed for the couplings, determines completely the Λ-N potential. The resulting potential has appeared too strong but slight adjustment of the coupling constant of the 0^+ I = 0 particle gave a very good agreement with the experimental data on Λ-N scattering. A rather strong tensor force operating in the Λ-N system was found, which may explain the existing discrepancy between the hypernuclear and fitted estimates of the strength of the Λ-N forces. (auth)

24683 MESON–NUCLEON COUPLING CONSTANTS FROM NUCLEON–NUCLEON FORWARD DISPERSION RELATIONS. Bugg, D. V. (Rutherford High Energy Lab., Chilton, Eng.). Nucl. Phys., B5: 29-46(1968).

Forward dispersion relations are applied to four spin-dependent nucleon-nucleon elastic scattering amplitudes. Data are taken from pp and pn phase shift analyses up to 630 MeV lab kinetic energy. Suitable combinations of amplitudes are chosen to separate singlet and triplet $\bar{N}N$ contributions from the u-channel. The former is dominated by the pion, but after this is removed there remains a significant effect from exchange of something heavier and of negative parity. The most likely source for this appears to be the 3π cut, although η exchange might account for some of it. The triplet $\bar{N}N$ contributions are dominated by ρ, ω, and σ mesons and are consistent with the absence of other contributors. If ρ alone contributes to the $N\bar{N}$ I = 1 discontinuity, $(g_{\rho 1} + g_{\rho 2})^2 = 23.0 \pm 1.0$ for a ρ mass of 750 MeV/c^2. The data are rather insensitive to the ratio $f_\rho = g_{\rho 2}\ g_{\rho 1}$, and give $f_\rho = 2.5^{+\infty}_{-0.85}$. If f_ρ is not to be considerably different from the value 3.7 predicted from the electromagnetic structure of the nucleon, the pn data require that contributions from exchange of 0^+ and 1^+ mesons with I = 1 should be small. Under the assumption that $g_{\omega_2} = 0$, the pp data give $g^2_{\omega_1} = 13.5 \pm 1.7$, and $g^2_\delta = 14.1 \pm 1.5$, $m_\delta = 813$ MeV/c^2. Two parameters of the deuteron may be determined by fitting the deuteron pole term. The effective range r_s of the deuteron is found to be 1.69 ± 0.02 fm, and the asymptotic ratio, ρ, of the D and S waves is 0.032 ± 0.005. (auth)

24684 PION EXCHANGE IN n–p SCATTERING AND PHOTOPRODUCTION. Wilson, Richard. Comments Nucl. Particle Phys., 2: 41-7(Mar.-Apr. 1968).

A brief historical review is given of the experimental and theoretical study of pion exchange in n-p scattering and photoproduction of π^+ and π^0. (L.B.S.)

24685 NUCLEAR CORRELATION AND FINAL INTERACTION IN THE ABSORPTION OF STOPPED π^- MESONS. Cheon, I. T. (Kyoto Univ. Kobe-Gakuin Coll., Japan). Phys. Lett., 26B: 549-51(Apr. 1, 1968).

Effects of the short-range N–N correlations and the final interactions on the negative pion absorption by ^{12}C nuclei are investigated. It is shown that these effects are very important in the processes. (auth)

24686 ABUNDANCES OF KAONS AND η-MESONS IN HIGH-ENERGY COSMIC RAY COLLISIONS. Pilkuhn, H. (Univ. of Lund, Sweden). Nucl. Phys., B4: 439-42(1968).

It is shown that a relatively small η-production significantly affects the ratio between γ-rays and charged pions in high-energy cosmic ray collisions. As a consequence, the $K^\pm/\pi^\pm$ ratio is increased to about 0.44. (auth)

24687 BINDING ENERGY OF A Λ-PARTICLE IN NUCLEAR MATTER. Grypeos, M. E.; Kok, L. P.; Ali, S. (International Atomic Energy Agency, Trieste, Italy). Nucl. Phys., B4: 335-42(1968).

A functional variation, under a suitable integral constraint, of the first-order ($\sim\rho - 0.172$ nucleon/fm^3) trial expression derived by Downs and Grypeos for the ground-state of a Λ-particle in nuclear matter, is performed. The general features of the approach described are discussed by using a simplified Λ-nucleon interaction. Estimates of the second-order terms ($\sim\rho^2$) are performed and comparison with previous calculations is also made. (auth)

24688 QUARK-MODEL INEQUALITY FOR NUCLEON–NUCLEON TOTAL CROSS SECTIONS. Pinski, G. (Drexel Inst. of Tech., Philadelphia). Nuovo Cim., 54A: 495-6(Mar. 21, 1968).

It is pointed out that a strict inequality for nucleon-nucleon total cross sections follows from the additive quark model with only charge independence for quark amplitudes. The limiting energy below which the inequality is violated is also noted. (L.B.S.)

24689 COUPLED-CHANNEL SCHROEDINGER EQUATION MODEL FOR NEUTRON–ALPHA AND DEUTERON–TRITON SCATTERING. De Facio, William Brian. College Station, Tex., Texas A and M Univ., 1967. 107p.

Thesis.

The two body states of neutron-alpha and deuteron-triton scattering were treated using rearrangement collision theory as formulated by R. G. Newton. The $\frac{5}{2}^+$ excited state of ^{5}He is explained as a strong coupling threshold effect instead of a resonance. In addition to the potential model studied, multichannel complex phase shifts are calculated for the n + α and d + T systems simultaneously. The results of extensive calculations to most of the existing data are presented and discussed. A good fit to all of the data is obtained. (Disser. Abstr.)

Particle Invariance Principles and Symmetries

General

Refer also to abstract 24567.

24690 (ITF–67-23) KLASSIFIKATSIYA NEPRIVODIMYKH PREDSTAVLENII POLUPROSTOI KOMPLEKSNOI GRUPPY LI. (Classification of Irreducible Representations of a Semisimple Complex Lie Group). Zhelobenko, D. P. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1967. 26p. (In Russian). Dep.

A short review of recent results on the theory of irreducible (not necessarily unitary) representations of a semisimple complex (and consequently noncompact) connected Lie group is presented. In particular, the complete classification of all such representations is given for a version of the statement of the problem. (Another version of classification has been proposed previously.) (auth)

24691 (ITF–67-32) SIMMETRII I IKH NARUSHENIYA V AKSIOMATIKE KVANTOVOI TEORII POLYA. (Symmetries and Their Violations in the Axiomatics of Quantum Field Theory). Vasil'ev, A. N. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1967. 40p. (In Russian). (CONF-670544–7). Dep.

From Conference on Axiomatic Quantum Field Theory and Elementary Particles, Kiev, USSR.

A rigorous statement of the problem of symmetry and its violations are considered in the framework of Wightman's axiomatics. (auth)

24692 OF C AND P AND T AND COMBINATIONS THEREOF. CERN Cour., 8: 11(Jan. 1968).

A short review is given of some of the news on the topic of symmetries from the research of 1967. The present experimental status is summarized. (L.B.S.)

24693 GROUP-THEORETICAL APPROACH TO COMPLEX ANGULAR MOMENTUM AND SIGNATURE. Toller, M. (CERN, Geneva). Nuovo Cim., 54A: 295-361(Mar. 21, 1968).

The relativistic two-body scattering amplitude is analyzed in terms of irreducible representations of the Poincaré group, which describe "objects" exchanged in the scattering process. These representations are obtained by the decomposition of the direct product of the representations, which describe an incoming and

an outgoing particle, respectively. This procedure, which uses only the invariance and unitarity properties of the amplitude, is analogous to the usual partial-wave expansion, and is called "crossed partial-wave analysis." Complex angular momentum appears as a quantum number describing the "exchanged objects." If the TCP invariance is taken into account also, the signature can be introduced in a natural way. The difficulties due to the fact that the representations considered are infinite-dimensional are discussed in detail. It is proved that the crossed partial-wave analysis can be performed for every invariant amplitude which satisfies the unitarity condition. However, the "crossed partial-wave amplitude" has to be considered as a bounded linear functional in a normed space of functions which depend on the quantum numbers which describe the "exchanged objects." Particles with arbitrary spins and parities are considered. The symmetry with respect to time and space inversions, and with respect to the exchange of identical particles, is taken into account. The role of the internal symmetry group is briefly discussed. (auth)

24694 ON THE REPRESENTATIONS OF THE GROUP SU(3). Majumdar, S. D. (Indian Inst. of Tech., Kharagpur). J. Phys., A, 1: 203-12(Mar. 1968).

By a generalization of techniques developed earlier for dealing with the three-dimensional rotation group O_3 the generators of the group SU(3) are expressed as differential operators involving four independent variables. The reduction in the number of variables simplifies the mathematical problem and makes it easier to study the properties of the group and its irreducible representations. From the forms of the new operators it becomes apparent that the basic states of an irreducible representation of SU(3) are linear combinations of Clebsch-Gordan series of SU(2) (or O_3). A convenient expression for the latter, which simplifies the derivation and also brings out the significance of certain steps more clearly, is obtained by a proper interpretation of the results given in an earlier paper by the author. Certain recursion relations for the Clebsch-Gordan coefficients of SU(2) are also found to be helpful for studying the SU(3) representations. These relations are derived in a novel way from Gauss's relations between contiguous hypergeometric functions. (auth)

24695 PHYSICAL ASPECTS OF THE CONFORMAL GROUP $SO_0(4.2)$. Castell, L. (International Atomic Energy Agency, Trieste, Italy). Nucl. Phys., B4: 343-52(1968). (IC-67/66).

It is shown how one arrives at the conformal group $SO_0(4.2)$ as a symmetry group of elementary particle physics. The reduction of the principal series of the most degenerate unitary irreducible representations of the conformal group with respect to the Poincare group is carried out using the results of the reduction with respect to the maximal compact subgroup. In addition the representation of the Lie algebra of the conformal group is transformed from coordinate space into momentum space and give the mathematical basis for a conform-invariant scalar field theory. (auth)

24696 PROJECTION OPERATORS AND CLEBSCH-GORDAN COEFFICIENTS FOR THE GROUP SU_3. Asherova, R. M.; Smirnov, Yu. F. (Moscow State Univ.). Nucl. Phys., B4: 399-412(1968).

Exact expressions for the projection operators for the group SU_3 were found. These operators were used to deduce a general analytic formula for the Clebsch-Gordan coefficients of this group. (auth)

24697 R(11) SYMMETRY AS AN ALTERNATE TO SU(6) SYMMETRY FOR ELEMENTARY PARTICLES. Smalley, Larry Lee. Lincoln, Neb., Univ. of Nebraska, 1967. 130p.

Thesis.

Predictions of R(11) symmetry are compared to those of SU(6) symmetry. Assuming the structure of the baryonic weak currents to be given by the regular representation with the baryons in 32 for R(11) and in 56 for SU(6) yields values of f_A in good agreement with experiment for R(11), but in bad agreement for SU(6). On the other hand, current commutation relations of time components of the strangeness changing and nonchanging axial-vector currents yield two values of f_A both in good agreement with experiment for SU(6), but both in bad agreement for R(11). Admixtures of different representations with the 56 in SU(6) can correct the poor value of f_A obtained from assuming a structure for the currents without changing the good values obtained from current commutation relations, since the commutators are equal to linear combinations of hypercharge and the third component of isotopic spin, both physically observable quantities. Admixtures of other representations with the 32 in R(11) can also correct the poor values of f_A obtained from current commutation relations there, since the commutators in R(11) depend on a physically nonobservable quantity; however, the value of f_A obtained from assuming a structure for the currents will also be changed, so that in this case the good prediction is lost. Mass formulas and decay widths are also investigated for R(11) and compared to the SU(6) case. R(11) predicts a second $J^P = \frac{1}{2}^+$ octet of baryons which must satisfy the Gell-Mann–Okubo mass formula, but more detailed predictions for these masses cannot be obtained. When the first member of the second octet is identified with the N*(1400), R(11) predicts a one pion decay width of 165 MeV, in reasonable agreement with the experimental width of 140 MeV. The decay widths for the other members of the second octet depend on their masses, but would most likely be very large, accounting for their nonobservance. It is noted that the predictions of SU(6) in this area are rather unclear, and apparently in poor agreement with experiment. Thus there appears to be no clear-cut choice between R(11) and SU(6) although SU(6) is preferable on grounds of simplicity. (Disser. Abstr.)

24698 MULTI-PION SYSTEMS; SYMMETRIES AND THE HYDROGEN ATOM. Levy, Donald Joseph. Los Angeles, Univ. of California, 1967. 146p.

Thesis.

Several multi-pion systems are studied. It is found that the sigma I = 0 J = 0 can exist as a four pion bound state. This four pion system is further studied by including the effects of the two pion channels. A coupled channel N/D calculation is carried out which determines the mass shift of the sigma due to the two pion channels, and determines the sigma's decay width into two pions. The connection between group properties and dynamical properties of systems of particles is considered. In particular, the hydrogen atom is studied which has O_4 symmetry for bound states and is related to the homogeneous Lorentz group for positive energy states. Properties of both positive and negative energy solutions of the homogeneous Schrödinger equation for the hydrogen atom are discussed. Then a general method is formulated for solving potential scattering problems. This method transforms the Lippman-Schwinger equations into integral equations on the group space of O_3. (Disser. Abstr.)

Applications (Electromagnetic and Weak)

24699 THREE-PHOTON INTERACTION AND THE CP VIOLATION. Dolgov, A. D. (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz., 7: 394-401(Feb. 1968). (In Russian).

A model of CP violation due to the transitions of one photon into two photons is considered. Experiments to test this hypothesis in pair photoproduction at high energy, in electron colliding beams, and in the electron Compton effect are discussed. Estimates are given for nucleon and lepton dipole moments and for CP-odd correlations in hadron decays. (auth)

24700 REFORMULATION OF THE DIRAC THEORY OF THE ELECTRON. Barut, A. O. (Univ. of Colorado, Boulder). Phys. Rev. Lett., 20: 893-5(Apr. 15, 1968).

It is shown that when the Dirac theory is formulated in the formalism of the dynamical group O(4,2), there is no need to invoke the hole theory or the notion of backward motion in time to describe antiparticles. A single irreducible representation of O(4,2) is used and the discrete operators P,C become inner automorphisms of the group. The most general linear minimal parity-violating equation generalizing the Dirac equation is shown to lead to two possible distinct mass values. (auth)

24701 DYNAMICAL SYMMETRY SCHEME WITH TRIPLETS OF INTEGRAL CHARGE. Raman, K. (Syracuse Univ., N. Y.). Nucl. Phys., B5: 125-39(1968).

A dynamical SO_{24} symmetry scheme based on two triplets of integral charge and hypercharge (termed trions) is considered; it is a dynamical extension of the symplectic symmetry scheme of Bacry, Nuyts and Van Hove. The normal baryons are assigned to the completely symmetric 2576 and the normal mesons to the 299 and 276. The electromagnetic properties of these baryons and mesons are discussed. Some differences between the predictions of schemes built on trions and those built on quarks are pointed out. (auth)

24702 CURRENT ALGEBRA AND K^+–K^0 MASS DIFFERENCE. Capra, F. (Laboratoire de Physique Theorique et Hautes Energies, Orsay, France). Nuovo Cim., 54A: 479-86(Mar. 21, 1968).

Weinberg's spectral function sum rules generalized to chiral SU(3) × SU(3) are used along with the soft-meson technique and the σ-model for calculating the $K^+ - K^-$ mass difference. It is shown that the σ-terms give an essential contribution to the kaon mass difference which reverses the sign of δm_K. (L.B.S.)

24703 YANG–MILL INTERMEDIATE BOSONS AND CP VIOLATION. Okubo, S. (Univ. of Rochester, N. Y. Univ. of Islamabad, Pakistan). Nuovo Cim., 54A: 491-4(Mar. 21, 1968).

A new model of CP violations is presented in connection with

the possible existence of intermediate vector mesons which may be Yang-Mill bosons. The model treats the leptonic, semileptonic, and nonleptonic interactions in a unified manner. (L.B.S.)

24704 ELECTRIC DIPOLE OPERATORS AND MIXED REPRESENTATIONS IN U(3) x U(3). Toth, K. (Central Research Inst. for Physics, Budapest). Nucl. Phys., B4: 450-4(1968).

The saturation of U(3) ⊗ U(3) algebra is examined in a special mixing scheme. It is shown that the model gives the right value not only for the proton-neutron axial-vector coupling parameters, but for the nucleon electromagnetic form factors and their first derivative at $q^2 = 0$ as well. (auth)

24705 O(3, 1) SYMMETRY AND THE FORWARD COMPTON SCATTERING OF VIRTUAL PHOTONS AT HIGH ENERGIES. Antoniou, N. G.; Palev, C.; Samiullah, M. (International Centre for Theoretical Physics, Trieste, Italy). Nucl. Phys., B4: 479-84(1968).

The high-energy behavior of the forward Compton scattering of virtual photons is studied within the context of O(3,1) symmetry. The results are compared with the predictions of the Regge model and various implications of the asymptotic behavior are discussed. (auth)

24706 PION FORM FACTOR AND MASS SPECTRUM OF BOSONS. Barut, A. O. (Univ. of Colorado, Boulder). Nucl. Phys., B4: 455-61(1968).

An assignment of all $I = \frac{1}{2}$ and $I = 1$ bosons within the framework of the dynamical group O(4,2) is proposed. The mass spectrum is obtained and new boson states are predicted. From the most general linear electromagnetic current in O(4,2) the pion form factor was evaluated and differs from the ρ-meson contribution at high momentum transfers, in agreement with a recent experiment. With the new form factor the contribution of the single-meson intermediate state to the $\pi^+ - \pi^0$ mass difference is 1.7 MeV. (auth)

Applications (Strong)

24707 (JINR-P2-3716) POLYARIZATSIONNYE OPYTY PO PROVERKE T- I CPT-INVARIANTNOSTI V NUKLON-NYKLONNOM I NUKLON-ANTINUKLONNOM RASSEYANII. (Polarization Experiments on the T- and CPT-Invariance Test in Nucleon-Nucleon and Nucleon-Antinucleon Scattering). Bilen'kii, S. M.; Lapidus, L. I.; Ryndin, R. M. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1968. 20p. (In Russian). Dep.

The experiments of the T-invariance test in elastic N-N scattering are discussed. The results of the experiments performed are given. The possible experiments on the CPT-invariance test in elastic proton-antiproton scattering are also considered. (auth)

24708 (JINR-P2-3758) E MEZON I MEZON-BARIONNOE RASSEYANIE V NARUSHENNOI $SU_w(6)$SIMMETRII. (E Meson and Meson-Baryon Scattering in the Broken $SU_w(6)$ Symmetry). Zaslavskii, A. N.; Tybor, V. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1968. 13p. (In Russian). Dep.

The consequences of the $SU_w(6)$ violation in the meson-baryon collision amplitudes are investigated. The obtained ratios between the process cross sections do not contradict the available experimental data. The broken $SU_w(6)$ symmetry allows one to conclude that ninth pseudoscalar E(1420)-meson is to be produced as often as the η-meson. (auth)

24709 RELATIVISTIC TRION MODEL FOR HADRONS. Ladanyi, K. (Hungarian Academy of Sciences, Budapest). Acta Phys. Acad. Sci. Hung., 23: 453-5(1967).

Some remarks are made about an SO(6) model of strong interactions. An appropriate description of the SO(6) model is provided by the trion theory. In this model the fundamental field is a (6 × 4)-component trion spinor $t_m(x\alpha)$, where α ($\alpha = 1 \ldots 4$) and m (m = 1 . . . 6) indicate the Dirac spinor and SO(6)-spin indices respectively. It is assumed that the field operator $t_m(x\alpha)$ satisfies a nonlinear spinor equation. (J.F.P.)

24710 O(3,1) SYMMETRY AND THE HIGH-ENERGY REACTION $\pi N \rightarrow \eta N^*(1236)$. Antoniou, N. G.; Komy, S. R.; Palev, C. D.; Samiullah, M. (International Atomic Energy Agency, Trieste, Italy). Nucl. Phys., B5: 195-200(1968).

The high-energy behavior of the reaction $\pi N \rightarrow \eta N^*$ was analyzed within the framework of O(3,1) symmetry based on the Delbourgo, Salam and Strathdee formalism. It is found that it is possible to fit the experimental data (within experimental errors) using the dominant contributions from the Lorentz states with $j_0 = 2$ and $j_0 = 0$ for the amplitudes $\langle \frac{3}{2}0|T|-\frac{1}{2}0\rangle$ and $\langle \frac{1}{2}0|T|\frac{1}{2}0\rangle$ respectively. (auth)

24711 MASS FORMULAS IN THE P_u GROUP. Zaikov, Raiko P.; Kademova, Krasimira V.; Palev, Chavdar D. Izv. Fiz. Inst. Aneb, Bulg. Akad. Nauk., 16: 149-64(1967). (In Bulgarian).

Disruption of the symmetry is introduced in the P_u group, which is a relativistic generalization of SU(6), by the requirement that the multidimensional impulse shall enter the complete set of the quantities observed simultaneously with the operators of the quantum numbers. Analogs are written of Dirac's equation of the twenty-component spinors describing the basic particles in the P_u symmetry. The masses of the mesonic 36-plet are found by means of linear invariant equations. A mass correlation of the third degree was obtained for the masses of the mesons which is satisfied with a precision of 0.2 per cent. Two linear correlations are also obtained whose accuracy is lower. (auth)

24712 STRONG DECAYS OF BARYONIC RESONANCES $\frac{3}{2}^-$ AND SU(3) SYMMETRY. Cremmer, E. (Faculte des Sciences, Orsay, France). Nucl. Phys., B4: 257-66(1968).

The strong decays of baryonic resonances $\frac{3}{2}^-$ into baryons and pseudoscalar mesons are studied in the framework of SU(3) symmetry. It is shown, by using a Lorentz-invariant form for the transition matrix element and taking into account the $Y_0^* - Y_0^*$ mixing, that the results are in agreement with experiment. (auth)

24713 ASYMPTOTIC CHIRAL SYMMETRY FOR ARBITRARY SPIN. Cook, P. A. (Univ. of Manchester, Eng.). Nucl. Phys., B4: 392-8(1968).

The idea that chiral SU(2) ⊗ SU(2) is a good asymptotic symmetry for hadrons is used to suggest sum rules relating even- and odd-parity isovector states of arbitrary spin. A supplementary relation is proposed, which then leads to a generalization of Weinberg's mass relation. (auth)

Field Theories

General

24714 AXIOMS OF THE SPECIAL THEORY OF RELATIVITY. Nozicka, Frantisek. Wiss. Z. Humboldt-Univ. Berlin, Math.-Naturwiss. Reihe, 16: 307-16(1967). (In German).

Attempts were made to construct a model of the special theory of relativity with the most fundamental concepts and axioms, while mathematical accuracy was maintained in the distinction between fundamental concepts, definitions, presuppositions, and assertions. One possible way was shown for obtaining, with fundamental concepts and assumptions, a conception of the four-dimensional Minkowski space, which is not a physical reality, but a suitable aid for explaining certain physical phenomena. In this sense its axiomatic structure differs from the systems of axioms described or indicated in previous treatments of the special theory of relativity, which had as their first aim a logical access to the establishment of the group of Lorentz transformations. (BBB)

24715 LOGIC OF SPECIAL RELATIVITY. Prokhovnik, S. J. New York, Cambridge University Press, 1967. 138p. $5.95.

The sources of the difficulties in the special relativity theory and apparent contradictions are discussed including the clock paradox and the apparent conflict between the principles of relativity and the cosmological viewpoint that the observable universe defines a preferred reference frame everywhere, namely that which makes the universe appear isotropic. The basis of the problems involved are presented, and the logic and limitations of various viewpoints regarding them are discussed. These problems are related to modern views of the universe, and it is indicated how they may be reconciled within a cosmological interpretation of the theory. Special relativity is presented as a theory whose continued development is linked with advances in physical knowledge and astronomical observations. (J.F.P.)

Quantum Field Theory

Refer also to abstracts 24517, 24691, and 24737.

24716 (ITF-67-43) GAMIL'TONOV FORMALIZM V PERENOPMIROVANNOI KVANTOVOI ELEKTRODINAMIKE. (Hamiltonian Formalism in Renormalized Quantum Electrodynamics). Svechnikov, S. V. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1967. 15p. (In Russian). Dep.

The method developed previously is applied to quantum electrodynamics. A modified Hamiltonian formalism provides an effective instrument for obtaining the commutators of currents. A more correct version of the mathematical formalism developed by B. V. Medvedev and M. K. Polivanov in the "pure renormalization" model is considered. (auth)

24717 (NYO-3829-22) A GENERALIZATION OF HAAG'S THEOREM. Streit, L. (Syracuse Univ., N. Y. Pittsburgh Univ., Pa.). Feb. 1968. Contract AT(30-1)-3829. 10p. Dep. CFSTI.

A generalization of the Haag theorem is presented. This generalization essentially consists in dropping not only locality but relativistic covariance altogether, in fact the notion of space (Euclidean versus e.g., lattice) need not be specified. (J.F.P.)

24718 CONFORM GROUP ON SPACE-TIME CURVE AND ASSOCIATED YANG AND MILLS FIELD. Kerbrat-Lunc, Helene (Institut Henri Poincare, Paris). Compt. Rend., Ser. A and B, 266: 29-31(Jan. 8, 1968). (In French).

A principal fibered space of the conform group structural group is constructed. The infinitesimal transformation law of the Yang and Mills field associated with the conform group is shown and explicitly calculated. (tr-auth)

24719 QUANTUM FIELD THEORY MODEL WITH SPECTRAL FUNCTIONS OF FAST INCREASE. Volkov, M. K. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 7: 445-53(Feb. 1968). (In Russian).

A four-dimensional unitary relativistic quantum field theory model without ultraviolet divergences with a nonunitary S-matrix is constructed on the basis of the Lagrangian: $L_{int}(x) = \Delta m : \psi(x)\tau_3 \exp\{-i2g\tau_1\varphi(x)\}\psi(x):$. (auth)

24720 UNITARITY AND THE SPIN-FAMILY SOLUTION. Van der Spuy, E. (Atomic Energy Board, Pelindaba, South Africa). Nucl. Phys., B4: 598-606(1968).

In continuation of the research on a second, strong-coupling type of solution of a suitable field equation of motion, namely the spin-family solution, the demands of unitarity are investigated. Beginning with a proposal for an asymptotic condition for general spin, the relation expressing unitarity for the two-point function is derived in terms of a complete set of asymptotic states with a general value of spin (integral or half-integral). This asymptotic unitarity condition is then applied to the proposed spin-family solution up to the second-order term. A number of relations involving the residues at the poles of the propagator are obtained. To satisfy these, one must have a positive-definite metric on the mass shells. Off the mass shells the indefinite metric associated with the unstable members of the spin family appears to require a background term in the propagator. The notion of local unitarity is then introduced in which the unitarity for the two-point function assumes an especially simple form, which is capable of explicitly showing the contributions with indefinite metric and due to the unstable poles in the local interaction domain. The form generalizes that for a free field and suggests that the spin-family solution should be approached as a generalized free field. This will generalize with respect to spin and momentum squared, and will be an infinite-component field off the mass shells. (auth)

24721 REMARKS CONCERNING THE POSSIBILITY OF FINITE CHARGE RENORMALIZATION IN SPINOR ELECTRODYNAMICS. Jackiw, R. (CERN, Geneva. Harvard Univ., Cambridge, Mass.). Nucl. Phys., B5: 158-68(1968).

The analysis of spinor electrodynamics, performed by Johnson, Willey and Baker, is examined by use of the renormalization group. It is concluded that the vanishing of the coefficient of the term proportional to log (m/M) in Z_3^{-1} is necessary, but not sufficient, for Z_3^{-1} to be finite. The mass assumption of the renormalization group is discussed, and explicitly verified through sixth order. (auth)

24722 INAPPROPRIATENESS OF THE ANOMALOUS MAGNETIC MOMENT AS A TEST OF QUANTUM ELECTRODYNAMICS. Okamoto, K. (Univ. of New South Wales, Kensington). Nucl. Phys., B4: 226-32(1968).

The anomalous magnetic moment of the electron or of the muon may not be appropriate as a test of quantum electrodynamics because of possible cancellation of different terms with opposite signs. The hyperfine splitting of the positonium or of the muonium, or comparison of μ-p and e-p scatterings, seems more appropriate. (auth)

24723 ANALYTIC BEHAVIOR OF ELECTRON PROPAGATOR FOR COMPLEX e^2/hc. Frieder, G.; Peres, A. (Technion-Israel Inst. of Tech., Haifa). Nucl. Phys., B4: 306-8(1968).

The formal sum of all the rainbow diagrams for the electron propagator leads to an integral equation which can be solved for $\mathrm{Re}\ \alpha > (3/16\pi^2)(\mathrm{Im}\ \alpha)^2$, but which is inconsistent in the remaining part of the complex α plane. Moreover, if $\mathrm{Re}\ \alpha > (3/8\pi^2)(\mathrm{Im}\ \alpha)^2$, it is possible to represent the solution by a converging series $\Sigma[A_j(s) + d(\alpha)B_j(s)]\alpha^j$, where all the non-analytic behavior is included in a single coefficient $d(\alpha)$. (auth)

24724 BOOTSTRAPPED SYMMETRIES AND OCTET GENERATION IN FIELD THEORY. Broido, Michael M. (Magdalen Coll., Oxford); Taylor, John G. Nucl. Phys., B4: 374-8(1968).

A simple and (in principle) exact field-theoretic mechanism which restricts the representations in which baryons may appear in the quark model is pointed out. Spinless quarks are discussed in detail and it is shown that only singlet, octet and decuplet baryons can appear. The quark dynamics arise from a field-theory bootstrap. (auth)

24725 AUTOCOMPOSITE ISOMULTIPLETS IN FIELD THEORY. Le Guillou, J. C. (CNRS, Paris. Univ., Paris). Nuovo Cim., 54A: 362-74(Mar. 21, 1968). (In French).

A study is made of the difficulty of a field-theoretical approach for autocomposite particles, as compared to the satisfactory one for allocomposite particles. It is then shown that the introduction of isospin, which is a characteristic property of observed particles that might be autocomposite, can remove this difficulty. This leads to satisfactory field theories where, after coherent elimination of the composite field, the other meson fields satisfy self-interesting nonlinear propagative equations. The quantization of such equations is given, although it is difficult to know the existence of sound solutions, and although the problem of constructing the composite state cannot be studied without a solvable model. Afterwards, it is shown within this approach the necessity for an autocomposite nucleon of not interacting only with pions; however satisfactory field-theories can be constructed with peculiar properties (for instance equality of bare-mass terms in the equations of pseudoscalar mesons) when there exists also an interaction with a pseudoscalar isosinglet (η). Finally, an example is given of a field theoretical "bootstrap" which does not reduce, as usual, only to constraints, but also contains propagative equations. (auth)

24726 WEINBERG SUM RULES IN A PERTURBATION-THEORETIC MODEL. Osborne, P. (Cambridge Univ., Eng.). Nuovo Cim., 54A: 427-40(Mar. 21, 1968).

The Weinberg sum rules are examined in a perturbation theoretic calculation based on the σ-model and find that only the first sum rule is valid. The same is true in a low-order quark-model calculation. A number of constraints on the invariant amplitudes for the three-point function are found to be inconsistent with the perturbation-theory calculation unless either a covariant Schwinger term is permitted in the equal-time commutator or seagull graphs are included in the model, thus demonstrating their equivalence. (auth)

24727 ON THE GENERALIZATION OF THE HAAG-RUELLE THEORY OF ASYMPTOTIC FIELDS. Lukierski, J. (Univ. of Wroclaw). Nuovo Cim., 54A: 500-3(Mar. 21, 1968).

It is shown how virtual processes can be described for asymptotic values of time by interpolating fields, defined by means of the off-mass-shell part of the field operator. (L.B.S.)

24728 RENORMALIZATION SCHEME FOR THE STRONG-COUPLING $\lambda\phi^4$ THEORY. Ezawa, H. (Gakushuin Univ., Tokyo); Nakamura, K.; Yamamoto, Y. Nuovo Cim., 54A: 512-15 (Mar. 21, 1968).

An attempt is made to formulate a renormalization scheme for the strong-coupling $\lambda\phi^4$ theory that yields covariant results. The violation of relativistic covariance resulting from the procedure of introducing a mass renormalization counter-term is circumvented by incorporating a coupling-constant renormalization. (L.B.S.)

Gravitation and General Relativity

24729 (ITF-67-41) PROBLEMA ODEVANIYA OPERATOROV V AKSIOMATICHESKOI KVANTOVOI TEORII POLYA. (Problem of Dressing the Operators in Axiomatic Quantum Field Theory). Sukhanov, A. D. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1967. 29p. (In Russian). Dep.

The problem of "dressing" various quantities under the action of the model β-matrix, corresponding to the counter term of the field renormalization, in the framework of axiomatic method is considered. The charge is conserved but the argument-function varies, that is, the field φ is changed to the field A_R, belonging to a nonequivalent representation of canonical commutation relations. The S-matrix, Heisenberg operators, various nonlinear relations as well as current-like operators A_n are "dressed." (auth)

24730 QUANTUM THEORY OF THE GRAVITATIONAL FIELD AND THE PLANCKIAN ELEMENTARY LENGTH. Treder, H. J. Monatsber. Deut. Akad. Wiss. Berlin, 8: 311-18(1967). (In German).

The three basic axioms of the quantum field theory are described: the Lorentz-Minkowski metrics of space-time, the existence of a clearly defined vacuum and thus of a universal Hilbert space, and compliance with the Einsteinian causality principle,

which excludes interactions between spatially adjacent points in the universe. It is shown that all attempts to combine the quantum theory and the theory of general relativity provide arguments to indicate that it is at least very doubtful that these three axioms are generally valid within a general-relativistic quantum field theory. The limits of validity were discussed on the basis of data from published references. The Planckian elementary length ($l = \sqrt{La}$; where L represents the geometric mean of the Compton lengths of the individual particles and a represents the Einsteinian gravity radius) characterizes the smallest space–time zones that can be measured experimentally. This consideration makes it impossible to establish the validity of the axioms in the very low ranges. (ATD)

24731 COSMOLOGICAL SOLUTIONS OF THE LORENTZ INVARIANT THEORY OF GRAVITATION. Mittelstaedt, P. (Univ., Cologne). Z. Phys., 211: 271-92(1968). (In German).

In the framework of the Lorentz invariant theory of gravitation a cosmology in the flat space-time is investigated. As in the Newtonian cosmology one starts from an infinitely extended system of incoherent matter under the influence of its own gravitational field. The field equations, the equations of motion and the world postulate of homogeneity and isotropy for geodetic observations lead then to the Friedman equation. In order to handle the coupled system of equations for the gravitational field and the matter a convenient approximation method is developed. The calculations are carried out in the second order of this method. The Einstein theory, which is in some respect equivalent to the Lorentz invariant theory of gravitation, serves as a guiding principle for formal developments. On the other hand the flat space-time cosmology presented gives rise to a new interpretation of the Einstein cosmology. (auth)

24732 CYLINDRICALLY SYMMETRIC CHARGED DUST DISTRIBUTIONS IN RIGID ROTATION IN GENERAL RELATIVITY. Som, M. M. (City College, Calcutta); Raychaudhuri, A. K. Proc. Roy. Soc. (London), Ser. A, 304: 81-6(Apr. 2, 1968).

A family of stationary cylindrically symmetric solutions of the Einstein–Maxwell equations corresponding to a charged dust distribution in rigid rotation is presented. The interesting feature of the solution is that the Lorentz force vanishes everywhere and the ratio of the charge density and mass density may assume an arbitrary value. The solutions do not appear to have any classical analogue. (auth)

24733 CHARGED SHELLS IN GENERAL RELATIVITY AND THEIR GRAVITATIONAL COLLAPSE. Kuchar, K. (Charles Univ., Prague). Czech. J. Phys., 18: 435-63(1968).

The boundary conditions for the gravitational and electromagnetic fields on charged shells are formulated. The shells are characterized in geometrical terms and the boundary conditions are manifestly covariant. The formalism is applied to the study of the gravitational collapse of homogeneous charged spherical shells. The law of conservation of energy, obtained by integrating the equations of motion of the shell and interpreted in full analogy with the special theory of relativity, is the starting point in analyzing the equilibrium states and the motion of the shells. It is concluded that no charge, however high it may be, can stop the gravitational collapse of the shell below the upper Nordström radius. (auth)

24734 MIXTURE OF OUTGOING AND INCOMING GRAVITATIONAL RADIATION; CHANGE OF MASS OF THE SOURCE OF RADIATION. Rotenberg, M. A. (Negev Inst. for Arid Zone Research, Beersheva, Israel). J. Phys., A, 1: 280-94(Mar. 1968).

It has been fairly well established theoretically that outward travelling spherical gravitational waves carry away energy from their source. Methods of successive approximations applied to the Einstein gravitational field equations of general relativity were used for that purpose. The object of the present paper is to show, by a double-series approximation method, a similar result for the general case of any mixture of outgoing and incoming radiation. (auth)

24735 REALITY OF THE SCHWARZSCHILD SINGULARITY. Janis, Allen I.; Newman, Ezra T.; Winicour, Jeffrey (Univ. of Pittsburgh). Phys. Rev. Lett., 20: 878-80(Apr. 15, 1968).

A spherically symmetric solution of the Einstein equations is presented that coincides with the exterior ($r > 2m$) Schwarzschild solution, but where the Schwarzschild "sphere" becomes a point singularity. The possible relevance of this solution to the question of gravitational collapse is discussed. (auth)

24736 CLASSICAL AND QUANTUM-FIELD-THEORETIC DERIVATIONS OF GRAVITATIONAL THEORY. Tryon, Edward Polk. Berkeley, Calif., Univ. of California, 1967. 133p.

Thesis.

Sets of postulates are presented for the classical and quantum theories of gravitation. The implications of these postulates are studied for the Lagrangian and Hamiltonian, respectively. Experience with quantum electrodynamics suggests that radiative gravitational energy corresponds to massless bosons of a unique spin, which are called gravitons. It is assumed that the graviton has a spin of two. The investigation of the classical theory is within the framework of flat-space, Lorentz-covariant, local Lagrangian field theory. Gravitation is represented by a real second-rank symmetric tensor field $\psi^{\mu\nu}(x)$, and matter by a real scalar field $\varphi(x)$. In general, a tensor field of rank equal to or greater than one corresponds to several spin values. For the vector field $A^{\mu}(x)$, requiring the free field to correspond only to massless spin-one particles forces the free equations to be unique, namely $\partial_{\nu}F^{\nu\mu} \equiv \partial_{\nu}(\partial^{\nu}A^{\mu} - \partial^{\mu}A^{\nu}) = 0$. For the tensor field $\psi^{\mu\nu}(x)$, requiring the free theory to contain only massless spin-two particles again forces the free equations to be unique. Defining $G^{\mu\nu}(x)$ by $G^{\mu\nu} \equiv \Box\psi^{\mu\nu} - \partial_{\nu}(\partial^{\mu}\psi^{\nu\lambda} + \partial^{\nu}\psi^{\mu\lambda}) + \partial^{\mu}\partial^{\nu}\psi^{\lambda}_{\lambda} + \eta^{\mu\nu}(\partial_{\lambda}\partial_{\rho}\psi^{\lambda\rho} - \Box\psi^{\lambda}_{\lambda})$, the unique free equations are $G^{\mu\nu} = 0$. Noting that $\partial_{\mu}\partial_{\nu}F^{\nu\mu} \equiv 0$ and $\partial_{\mu}G^{\mu\nu} \equiv 0$, one sees that both the vector and tensor fields are coupled to sources which are divergenceless when the equations of motion are satisfied. A method for constructing divergenceless tensors of arbitrary rank, for any local field theory where the equations of motion are known is developed. Then this method is used to establish iteration procedures for constructing Lagrangian theories which describe the interactions of photons and gravitons with massive scalar mesons. The complete solution to the iteration equations is obtained for the Lagrangian describing the interaction of $A^{\mu}(x)$ with a scalar field $\varphi(x)$ through a dimensionless coupling constant e. The solution is unique, namely the Lagrangian of scalar electrodynamics is applied. Next iteration procedure is applied to construct Lagrangians describing the interaction of $\psi^{\mu\nu}(x)$ with $\varphi(x)$ through a coupling constant g ~ length. The iteration equations are solved to first order in g, and it is found that the first-order equations permit a multi-parameter family of Lagrangians. When the second-order iteration equations are solved, many of the first-order parameters are related to one another. It is proven that the second-order equations require the first-order Lagrangian to contain a purely gravitational term, a result which has been anticipated previously. It is also proven that the second-order equations permit at least two distinct expressions for the purely gravitational term in the first-order Lagrangian, a result which conflicts with previous work. It seems possible that the iteration equations have only one solution when solved to all orders, but the limited work does not justify any conclusions about uniqueness. It is verified to second order in g that Einstein's theory corresponds to one solution of the iteration equations. The investigation of the quantum theory is within the framework of interaction-picture perturbation theory. An attempt is made to construct the interaction Hamiltonian density $\mathcal{H}_I(x)$ as an explicit function of the creation and annihilation operators for free bare-particle states. Gravitons are represented in coordinate space by "potentials" which contain operators for only the two physical states of polarization. Limiting the graviton potential to contain only the two transverse states of polarization makes Lorentz invariance of the S-matrix difficult to achieve. It is required of the Hamiltonian that it yield a Lorentz-invariant S-matrix, and thereby obtain nontrivial restrictions on $\mathcal{H}_I(x)$. Unique amplitudes are derived for meson-graviton and graviton-graviton scattering in lowest order, assuming only the form of the one-graviton two-meson vertex. The results are precisely those of Einstein's theory, as quantized by Gupta and Feynman. (Disser. Abstr.)

24737 CONTRIBUTION TO THE QUANTUM THEORY OF GRAVITATION. Freeman, Michael James. Vancouver, B. C., Univ. of British Columbia, 1967.

Thesis.

A quantum theory of gravitation is constructed, by considering the gravitational field in the linear approximation to be a rank II tensor field, which has imposed upon it the auxiliary conditions of symmetry, transversality, and tracelessness. Extensive use is made of the close analogy between the electromagnetic field as a special case of a vector field, and the gravitational field as a special case of a tensor field. This analogy includes the necessity of introducing an indefinite metric in order to make the auxiliary conditions compatible with the commutation relations. A complete theory of gravitation must take into account the gravitating nature of gravitation and hence must be a nonlinear theory. A method proposed by Gupta of iterating the linear field equations for this purpose is investigated, and it is shown that this method fails, because the Lagrangian for the second order equations does not exist. An alternative method of iteration is proposed which avoids this problem, and which yields a functional equation for the Lagrangian of the full nonlinear theory. Finally, the problem of photon-photon scattering due to the gravitational interaction is investigated. This is done by constructing an interaction Hamil-

tonian by using the principle of the compensating field and then applying the standard methods of quantum electrodynamics. It is found that for sufficiently high frequencies this process dominates the purely electrodynamic scattering of photons by photons. (Disser. Abstr.)

Scattering Theory

Refer also to abstracts 24693 and 24893.

24738 (ITF-67-22) SINGULAR POTENTIAL WITH A POWER SINGULARITY IN QUANTUM MECHANICS. Yatsun, V. A. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1967. 26p. Dep.

It is established that in the nonrelativistic problem of scattering by a strongly repulsive singular potential with a power singularity at the zero point, the regularization can be associated with an extension of the Schrödinger singular operator in a Hilbert space. (auth)

24739 RELATIVISTIC EXTENSION OF THE LE COUTEUR–NEWTON FORMALISM. Leruste, Philippe; Malamant, Alexandre (College de France, Paris). Compt. Rend., Ser. A and B, 266: 305-7(Feb. 5, 1968). (In French).

It is shown that if one assumes the invariance under time reversal and averages the conditions known as extended unitarity, the scattering amplitude of a two-way process (corresponding to a given group of the values of the quantum numbers) can be expressed by means of a single function defined in the complex plane of a new variable. (tr-auth)

24740 GENERALIZATION OF HAAG'S THEOREM IN SCATTERING THEORY. Garczynski, W. (Univ. of Wroclaw). Nucl. Phys., B4: 689-99(1968).

A simple proof of Haag's theorem for the Jost model is given. Our method, different from the known ones, enables the Haag's theorem to be generalized in a sense that the invertibility property of $W_\lambda(t)$ mappings for any fixed time and its boundedness, instead of the unitarity requirement, is already sufficient to make a theory physically trivial. (auth)

24741 DISPERSION SUM RULES FOR NON-DECREASING AMPLITUDES. Enkovski, L. (Joint Inst. for Nuclear Research, Dubna, USSR). Nucl. Phys., B5: 119-24(1968).

Sum rules for scattering amplitudes as consequences of analyticity are derived. It is not necessary to assume for the derivation of these relations that the corresponding analytic functions tend to zero while $s \to \infty$ or $t \to \infty$. Comparison with experiment is carried out. (auth)

24742 CONSTRUCTION OF A SEPARABLE HAMILTONIAN. II. Pearson, D. B. (Univ. of Hull, Eng.). Nuovo Cim., 54B: 191-213(Apr. 11, 1968).

The iterative method of constructing a separable Hamiltonian from a given scattering amplitude is extended to simple cases of many-channel scattering. Convergence of the iteration is proved if the coupling is sufficiently weak. (auth)

24743 SINGULARITY PROPERTIES OF THE BUBBLE DIAGRAMS OF S-MATRIX THEORY. Branson, D. (Princeton Univ., N. J.). Nuovo Cim., 54A: 217-33(Mar. 21, 1968).

A general discussion is given of singularity properties arising from the "contraction" of internal lines of the "bubble diagrams" of S-matrix theory, such as the terms of unitarity equations. The circumstances in which one may contract such internal lines are described and an argument is given for deciding what part of the resulting curve is actually singular. The relevance of these results to the derivation of singularity properties of scattering amplitudes from unitarity is discussed. (auth)

24744 GRIBOV–POMERANCHUK SINGULARITY AND INELASTIC N/D EQUATIONS. Bassetto, A.; Paccanoni, F. (Univ., Padua. Istituto Nazionale di Fisica Nucleare, Padua). Nuovo Cim., 54A: 532-5(Mar. 21, 1968).

Gribov-Pomeranchuk singularities in the angular momentum plane are examined, considering the equal-mass spinless neutral case, and taking into account inelastic processes by means of the N1D equations in the Frye–Warnock formulation. (L.B.S.)

Particle Accelerators

Refer also to abstracts 23207, 24567, and 24570.

24745 (BNL-10630) EMITTANCE MEASUREMENTS OF THE 1-GeV BEAM FROM THE BROOKHAVEN COSMOTRON. Bennett, G.; Friedes, J. L.; Palevsky, H.; Sutter, R. (Brookhaven National Lab., Upton, N. Y.); Igo, George (Los Alamos Scientific Lab., N. Mex.); Simpson, W. D. (Rice Univ., Houston, Tex.); Corley, D. (Maryland Univ., College Park). Sept. 21, 1966. Contract AT(30-2)-Gen-16. 7p. Dep. CFSTI.

The experimental apparatus consists of a wire spark chamber magnetic spectrometer which measures the horizontal and vertical emittance of the beam at the target position. The spark events are analyzed on-line by a computer which generates emittance plots. (W.H.K.)

24746 (BNL-12356) PRELIMINARY SPACE-CHARGE CONSIDERATIONS IN THE AGS. Claus, J. (Brookhaven National Lab., Upton, N. Y.). Mar. 11, 1968. 37p. Dep. CFSTI.

Calculations for the beam envelope and particle motion for symmetric and nonsymmetric beams which are matched and unmatched are presented and discussed. Also, considerations for improving the model are given. (W.H.K.)

24747 (BNL-12375) BEAM DEFLECTING ELEMENTS AND THEIR EFFECT ON CLOSED ORBITS IN THE AGS. METHOD OF CALCULATION WITH ILLUSTRATIVE EXAMPLES. Vogel, U. (Brookhaven National Lab., Upton, N. Y.). [1967]. 27p. Dep. CFSTI.

A procedure for calculating closed orbits in the AGS is presented. The calculations take into account the beam deflecting elements which are used to correct for perturbations in the ring fields and to control or steer the proton beam onto internal targets and exit slits. (W.H.K.)

24748 (CEAL-1039) SEMIANNUAL REPORT [ON ELECTRON ACCELERATOR], JULY 1–DECEMBER 31, 1967. (Cambridge Electron Accelerator, Mass.). Mar. 4, 1968. Contract AT(30-1)-2076. 47p. Dep. CFSTI.

The operation of the 6-GeV Cambridge Electron Accelerator is described. Changes in the administrative organization of the laboratory are also reported. The general natures of the 30 experiments that were in progress or in preparation are summarized. The principal improvements made in the accelerator and in the associated facilities are listed. The progress made on Project Bypass is summarized, and it is shown that long-term storage up to 30 minutes at 3 GeV and multi-cycle injection affording a buildup factor exceeding 100 were accomplished successfully. Safety is discussed, and it is seen that there were no lost-time accidents and no excessive radiation doses. The Sixth International Conference on High Energy Accelerators, held at Cambridge, Massachusetts, on September 11–15, 1967 is discussed. Publications resulting from work done at the CEA are listed. (auth)

24749 (CERN/DI/HP-45(Rev.)) TIME VARIATION OF THE DOSE RATE FROM RADIOACTIVITY INDUCED IN A HIGH-ENERGY PARTICLE ACCELERATOR. Sullivan, A. H.; Overton, T. R. (European Organization for Nuclear Research, Geneva (Switzerland)). July 6, 1964. 12p. Dep.

On the basis of an empirical half-life distribution of isotopes, a formula has been derived which can be used to predict build-up and decay of radioactivity induced in a high-energy particle accelerator. Comparisons between the predictions of this formula and experimental results show agreement within a factor of two. (auth)

24750 (IEA-144) MATRIX REPRESENTATION FOR CALCULATION OF THE SECOND ORDER ABERRATIONS IN PARTICLE OPTICS FOR HOMOGENEOUS AND INHOMOGENEOUS ($n = 1$) MAGNETIC FIELDS. Suarez, A. A.; Coutinho, F. A. B. (Instituto de Energia Atomica, Sao Paulo (Brazil)). Apr. 1967. 23p. Dep.

The general theory of beam transport optics is used to find out the matrix elements corresponding to the motion of a particle in homogeneous and inhomogeneous ($n = 1$) magnetic fields. This theory was extended for the rotation of the field boundary. (auth)

24751 (PPAD-636-D) SPACE CHARGE EFFECTS ON BEAM EMITTANCE MEASUREMENTS. Prelec, K.; Passner, A. (Princeton-Pennsylvania Accelerator, Princeton, N. J.). Jan. 26, 1968. Contract AT(30-1)-2137. 18p. Dep. CFSTI.

The problem of measuring the emittance of a beam under strong space charge forces has been examined. The various standard experimental methods have been studied to learn the distorting effect of space charge on the measured values of emittance. The work indicates that certain methods would increase the apparent emittance while others would decrease its value. An experimental method is proposed that would reduce to a minimum the distorting effect of space charge on the measured value of emittance. (auth)

24752 (UCID-15296) COMPTON BACKSCATTERING OF OPTICAL PHOTONS AS A POSSIBLE SOURCE OF POLARIZED PHOTONS FOR THE LIVERMORE EXPERIMENTAL PROGRAM. Schneider, Stanley; Spitzer, Richard (California Univ., Livermore. Lawrence Radiation Lab.). [1965]. Contract W-7405-eng-48. 20p. Dep. CFSTI.

A preliminary study is made of Compton backscattering of laser photons as a mechanism for producing useful fluxes of monoenergetic and polarized photons for the Livermore experimental program. Estimates are made of the expected flux and energy spectrum on the basis of a ruby laser and of the existing and proposed Livermore accelerators. Possible applications are suggested. (L.B.S.)

24753 QUADRAPOLE MAGNETIC FIELD LENS WITHOUT IRON. Tanguy, Pierre (Univ., Rennes, France). Compt. Rend., Ser. A and B, 266: 314-16(Feb. 5, 1968). (In French).

It is shown that it is possible to develop an iron-free quadrupole magnetic field lense. (tr-auth)

24754 ELECTRON RING ACCELERATORS. Cern Cour., 8: 28-30(Feb, 1968).

A general explanation of the principles underlying a new accelerator technique and a description of the work which has been done at Dubna and which is starting at LRL are presented. (auth)

24755 WESTON ACCELERATOR. Cern Cour., 8: 31-4(Feb, 1968).

The proposed Weston 200-to-400-GeV proton synchrotron is discussed. Topics discussed include the site, main ring, injection, and ejection. (W.H.K.)

24756 NEW SYNCHROTRON INJECTOR. Reich, K. H. Cern Cour., 8: 3-9(Jan, 1968).

A new injection system for the CERN proton synchrotron is described. The need for a new injector, its basic performance specifications, the various possibilities considered, and the final choice are discussed. The system involves four synchrotrons stacked one on top of another. They will be fed by the existing 50-MeV linac and will boost the energy of the protons to 800 MeV. (W.H.K.)

24757 TUBE FOR FAST NEUTRON PRODUCTION. Bobrowski, Czeslaw; Massalski, Jerzy (Kharkov Inst. of Nuclear Technology). Nukleonika, 13: 115-24(1968). (In Polish).

Acceleration voltage, insulation, length of accelerating gap, criteria for work parameters of deuterium containers, and criteria for the tritium target parameters are discussed. The influence of the electric field distribution along the symmetry axis on the characteristics of the ion source are discussed. Neutron yields of the order of 10^8 n/s have been obtained, and an improved neutron tube is described which will produce 10^9 n/s. (auth)

24758 THE WITHDRAWAL BY A GRADUAL FIELD CHANGE OF AN ACCELERATED BEAM IN THE INS ELECTRON SYNCHROTRON. Kazuo, Huke; Kobayashi, Yoshiyuki (Tokyo Univ.). Genshikaku Kenkyu, 12: 368-91(Dec. 1967). (In Japanese).

We had extracted an electron beam from INS Electron Synchrotron by Piccioni's method. Recently the extraction method was improved for the extraction efficiency and the energy of the extracted electron beam by the resonance method. Our resonance method consisted of a single current strip, and two kicker magnets. The current strip, located inside of the circulating beam, excited a one-third resonance and kicked the beam into the first kicker magnet. The measured maximum extraction efficiency was ~54% and the maximum energy of the extracted electron was ~1000 MeV. (auth) (NSA of Japan)

24759 ON THE ION OPTICS OF THE HORTIG HEAVY ION ACCELERATOR. Sona, P. G. (CISE, Milan. Univ., Milan); Sona, P. Energ. Nucl. (Milan), 15: 264-7(Apr. 1968).

Betatron oscillations are induced in the static field accelerator for heavy ions of the Hortig type, by the coupling between charge fluctuations and magnetic field imperfections. The induced amplitudes are estimated and the need for good compensating mechanism is pointed out. A new arrangement of magnetic deflectors is also proposed. (auth)

24760 NEGATON TO POSITON CONVERSION YIELD. I. MEASUREMENTS. Jacobs, R. J.; Creten, W. L.; Ferdinande, H. M.; Vanhuyse, V. J. (Univ., Ghent). Nucl. Instrum. Methods, 61: 157-65(May 1968).

The negaton to positon conversion yield differential in positon energy and solid angle has been measured for negaton kinetic energies ranging from 2.0 to 4.0 MeV and for various converter materials and thicknesses (Cu: 138 mg/cm^2, Ag: 203 mg/cm^2 and Au: 29.8 to 759 mg/cm^2). Angular distributions of the emerging positons have been determined for gold targets with thicknesses of 58.1, 203 and 759 mg/cm^2 at incoming negaton energies of 2.0 and 3.5 MeV. (auth)

24761 INEXPENSIVE SYSTEM FOR DEFINING AND MONITORING EXTERNAL ACCELERATOR BEAMS. Mewaldt, R. A.; Dos Santos, A.; Head, R.; Hafele, J. C. (Washington Univ., St. Louis). Nucl. Instrum. Methods, 61: 235-6(May 1968).

An inexpensive system for defining and monitoring external accelerator beams is described. The system includes a transistorized dc nanoammeter which indicates the current stopped by an adjustable double-slit system of simple design. (auth)

24762 NEGATON TO POSITON CONVERSION YIELD. II. THEORETICAL EVALUATION. Jacobs, R. J.; Ferdinande, H. M.; Creten, W. L.; Vanhuyse, V. J. (Univ., Ghent). Nucl. Instrum. Methods, 61: 166-72(May 1968).

An approximate analytical expression is derived for the energy distribution of positons leaving a negaton bombarded target in the forward direction. The approximation restricts the validity of the formula to converter thicknesses one order of magnitude smaller than the value of the range of the bombarding negatons. Comparisons are made with experiments in the low (2.0 to 4.0 MeV) and medium (24.5 MeV) negaton kinetic energy region; the agreement is satisfactory. (auth)

24763 THIRD HARMONIC SIMULATED BUNCHER. Goldstein, C.; Laisne, A. (Institut de Physique Nucleaire, Orsay, France). Nucl. Instrum. Methods, 61: 221-5(May 1968).

Without any bunching, the theoretical efficiency of the linac phase acceptance $\eta = 3|\varphi_s|/2\pi$ is 16.6% ($\varphi_s = -20°$). With a classical buncher this efficiency increases up to 65%. A high efficiency buncher using the fundamental frequency and its second harmonic to simulate the third one is proposed. The theoretical efficiency of this system is 88%. Practically, it is possible to achieve a gain of 5 with a third harmonic simulated buncher instead of 3 with a classical buncher. (auth)

24764 HIGH POWER BROADBAND FREQUENCY MODULATION OF HIGH Q RESONATORS. Mackenzie, K. R. (Univ. of California, Los Angeles). Nucl. Instrum. Methods, 61: 134-40 (May 1968).

The analysis indicates that the simple overcoupled transformer with non-identical primary and secondary circuits is the optimum coupling arrangement between tube and resonator. When $\delta\omega/\omega \ll 1$ a fundamental limitation, dependent on tube parameters only, is derived in the form of a voltage bandwidth product $V_2\delta\omega = 1.4g$, where V_2 is the peak rf plate voltage (at both normal mode frequencies) and g is the ratio of the tube emission current to its capacity. This relation shows that the tube should be operated at low voltages if wide frequency ranges are desired. The maximum resonator voltage V_1 (constant throughout the range) is found to be limited by the expression $V_1(\delta\omega)^2 = 2\omega g$. A compromise between range and power, using a programmed dc plate voltage, yields the relation $P = 0.16(V_1)^2C\delta\omega'$ where C is the resonator capacity and $\delta\omega'$ is roughly 90% of the possible range $\delta\omega$. (auth)

24765 STRAGGLING DISTRIBUTIONS OF LARGE ENERGY LOSSES. Tschalar, C. (Rutherford High Energy Lab., Chilton, Eng.). Nucl. Instrum. Methods, 61: 141-56(May 1968).

The energy straggling distributions of non-relativistic heavy particles passing through a homogeneous absorber are determined for energy losses of up to 80% of the initial particle energy. Included is the single collision distribution for very small energy losses. The distributions are found to be most symmetrical at energy losses of about 50%. However, their asymmetry increases noticeably toward larger energy losses. The calculations are valid for initial energies of up to 30% of the particle rest energy. The lower energy limit is determined by the inner shell connections to the stopping power and by charge pick-up which were both neglected. The results apply to all absorber materials. (auth)

24766 LINEAR THEORY OF THE CYCLIC ACCELERATORS OF RELATIVISTIC CHARGED PARTICLES FOR THE CASE OF SMALL RADIATION LOSSES. Kozubovskaya, I. G.; Sharshanov, A. A. (Kiev Inst. of Mathematics. Kharkov Inst. of Physics and Tech.). Ukr. Fiz. Zh., 13: 3-10(Jan. 1968). (In Russian).

An expression is derived for the phase volume of the domain specified by the condition that any integral curve passing through the domain is contained in a given volume of the accelerator chamber. (auth)

24767 OBTAINING THE Ru FOILS FOR NUCLEAR RESEARCH AND INVESTIGATION FOR RUTHENIUM, RHODIUM, AND PALLADIUM DEPOSITS. Medyanik, V. N.; Kadaner, L. I. (Kharkov Inst. of Physics and Tech. Kharkov Teacher's Inst.). Ukr. Fiz. Zh., 13: 127-9(Jan. 1968). (In Russian).

The ruthenium target foils of three and more microns are obtained. The Ru and Rh deposits have the increased internal tension. The dependence was studied of the internal tension of the Ru, Rh, and Pd deposits on metal concentration in an electrolyte and on current density. An accurate regularity for the electrolytes under investigation could not be revealed. An investigation of current density influence on the current yield over the wide concentration range was carried out. The gas analyses of the Ru, Rh, and Pd deposits were conducted. (auth)

24768 ON THE EQUILIBRIUM OF A ROTATING CONFIGURATION WITH ELLIPTICAL DISTRIBUTION OF VELOCITIES IN THE PRESENCE OF A MAGNETIC FIELD. Movsesyan, R. E. (Erevan State Univ.). Izv. Akad. Nauk Arm. SSR, Ser. Fiz., 2: 373-6(1967). (In Russian).

The equilibrium of a self-gravitating configuration is considered taking into account the rotation in the presence of a magnetic field. (auth)

24769 ENERGY LOSSES OF A PARTICLE PASSING THROUGH A THREE-LAYER PLATE. Muradyan, M. M. (Inst. of Physics, Erevan). Izv. Akad. Nauk Arm. SSR, Ser. Fiz., 2: 343-51(1967). (In Russian).

Total energy losses of the charged particle passing through a three-layer plate, when the thickness of the layer is not limited, are considered. The obtained general formula is thoroughly calculated and analyzed for the case of thin layers. It is shown that, when the regions of the proper frequencies of the materials of the layers are indistinct from each other, the ionization losses in all three layers grow logarithmically as in the case of three independent one-layer plates. (auth)

24770 PERFORMANCE OF MITSUBISHI CLINICAL LINEAR ELECTRON ACCELERATOR LAS-M. Tatuno, I. (National Kanazawa Hospital, Japan); Matiyama, Y. Mitsubishi Juko Giho, 4: 581-8(Nov. 1967). (In Japanese).

Mitsubishi Clinical Linear Electron Accelerator LAS-M is now showing stabilized performance as a production machine. The LAS-M unit installed in the Kanazawa National Hospital is showing smooth performance in its daily therapeutic services since its opening of treatment operation in March this year. The results of its application to therapy and diagnosis are reported and the availability of LAS-M as a cancer treating machine is claimed. Further, they present clinical data on superhigh voltage radiography (linacgraphy) and therapeutic planning. (auth) (NSA of Japan)

24771 BUILDINGS OF ML-300 ELECTRON LINAC FOR TOHOKU UNIVERSITY. Okajima, Nobuo; Yamamoto, Moriyuki (Taisei Construction Co., Ltd., Japan). Mitsubishi Denki Lab. Rep., 42: 276-86(Feb. 1968). (In Japanese).

The main assembly of accelerator and beam transport systems are located 6 m under the ground and extend 71 m in total length. One of the beam transport systems is perpendicular to the direction of the accelerator, branching 11 m long. The accelerator room is 57 m long and 3 m wide with a 2.3 m wide side space for the piping system. The load distribution is unbalanced due to irregular configuration of the layout together with massive and heavy shieldings. The text explains the solution of difficult problems of the selection and layout of the buildings. Location of radiation sources and their mechanisms of generation shall be reasonably assumed to set the intensities of radiation levels and the concentration of toxic gases as basic criterions of the shielding. Many problems remain unsolved, especially for engineering practice of shielding design concerned with these hypothetical selections. Calculations suggested by Prof. Kimura have been examined as well as those derived from experiments abroad in the selection of proper methods to guard against the radiation hazard, thus dimensional control being provided from the viewpoint of engineering practice with safe shielding constitution. (auth) (NSA of Japan)

24772 DOSE DISTRIBUTION IN HIGH ENERGY ELECTRON BEAM THERAPY. Hattori, Hiroyuki (Aichi Cancer Center, Japan). Nippon Igaku Hoshasen Gakkai Zasshi, 27: 1211-16 (Dec. 1967). (In Japanese).

Dose distribution and other properties of electron beam were studied experimentally in a 31 MeV betatron. Scattering foils used were made of lead and nickel, and their thickness was chosen as to dose distribution flat in air at the top of the cone for a field size of 10×10 cm in each energy. Cones were made of two layers of metal, the inner, aluminum, and the outer, lead, with the thickness to diminish leakage of radiation down to $1/100$. Dose distribution in a water phantom was measured by an isodose plotter. The isodose and depth-dose curves obtained are illustrated. Nominal energy values of electron beam were a little larger than effective values estimated experimentally by means of measurements of extrapolated range of electron beam and of activating threshold energy. (auth) (NSA of Japan)

24773 A 6 MeV ELECTRON LINEAR ACCELERATOR. II. OPERATION CHARACTERISTICS. Kanaji, Toru; Ikuta, Shiro (Government Industrial Research Inst., Nagoya, Japan). Nagoya Kogyo Gijutsu Shikensho Hokoku, 16: 326-35(Oct. 1967). (In Japanese).

An electron linear accelerator is composed of many devices, and the characters of radiated electron beams are complicatedly influenced by the operational states of the devices. Among the characters, energy, intensity, and shape of the energy distribution curve are considered to be the most significant factors. The influences of the operating states upon the characters were studied. Emission current from electron gun, frequency and power of micro-wave were the most important factors. The relations among the six factors were discussed, and a synthetic operation chart of an electron linear accelerator was obtained. In addition to the above results, some influences of auxiliary factors upon the characters were clarified. (auth) (NSA of Japan)

24774 ON THE CHARACTERISTICS OF THE OREITAL RADIATION OF ELECTRON SYNCHROTRON OF INS. Oshio, Takanori; Sasanuma, Michio (Osaka City Univ.). Oyo Butsuri, 37: 43-53(Jan. 1968). (In Japanese).

In recent years, the orbital radiation from the electron synchrotron is utilized as a light source in the soft x-ray and vacuum ultraviolet region. The characteristics of the radiation are clarified in the case of the INS electron synchrotron. The power spectral distributions, the angular power distributions, and the relation of the emitted power spectrum to the electron energy are given. The practical intensities of the radiation, which enter a 10 micron slit at the experimental site 8 meters apart from the orbit, are tabulated for various wavelengths and electron energies. (auth) (NSA of Japan)

24775 EFFECT OF SPACE CHARGE ON THE ELECTRODYNAMIC PROPERTIES OF THE ACCELERATING STRUCTURE. Loncar, Goiho. Acta Tech. CSAV, No. 1, 80-9(1967). (In Czech).

A theoretical investigation is made of the effects of the space charge carried by the electron beam in a linear accelerator of the diaphragmed-waveguide type on the accelerating field and the electron velocities in the beam. The numerical value of the nominal velocity is $\beta = 0.4$ c in the example. A steady-state beam with a diameter equal to the diaphragm-opening diameter with small fluctuations of velocity and charge density is considered. This makes it possible to linearize the general equations of particle motion and to obtain a simple solution. The resulting formulas, however, do not predict appreciable effects of high beam intensities up to as much as 1 amp, showing the inadequacy of the approximation. In the second part of the article, a bunched beam (bunch diameter 6 mm, length 11.4 mm, intensity 0.2 amp) is considered, and it is shown on the basis of simple electrostatic relations, that space charges in such an electron bunch cause field variations of over 1 kV/cm. In experimental accelerator work it was found that optimum values of injection voltage for high-intensity beams are different from those computed for an isolated particle. (ATD)

24776 ELECTRON GUN USING A FIELD EMISSION SOURCE. Crewe, A. V. (Argonne National Lab., Ill. Univ. of Chicago); Eggenberger, D. N.; Wall, J.; Welter, L. M. Contract AT(11-1)-1721. Rev. Sci. Instrum., 39: 576-83(Apr. 1968). (COO-1721-1).

A new electron gun has been built which features mechanical and optical simplicity. Theoretically, it can produce a focused spot having a radius smaller than 50 Å and provide 1000 times more intensity than a hot filament system having a similar final spot size. The increase in intensity is made possible by using a field emission electron source operating at a pressure of 10^{-9} torr, which is provided (without baking) using commercially available pumps. The small spot is produced by using two properly shaped electrodes which accelerate and focus the electrons from the tip. The optical properties for the new gun were predicted on a computer and experimentally confirmed in a new scanning electron microscope. The aperture aberration coefficient was measured to be no more than a factor of two greater than the theoretical value of 1.5 cm. A spot radius of 250 Å has been measured, and this value is to be compared with the theoretical value of 150 Å. Although it was convenient to measure the spot directly only at a relatively large image distance (11.3 cm), calculations imply that the gun can provide a spot radius less than 25 Å when very small image distances are used. The gun can be used in pulsed operation because all optical properties are constant for a given voltage ratio so that application of the electrode voltages by means of a voltage divider provides automatic focusing for arbitrary changes in the applied voltage. The methods used to make and operate reliable high field emission tips are reviewed, and a technique is described for changing the required tip voltage to obtain a given emission current. (auth)

24777 HIGH-Z CYLINDRICAL SPARK CHAMBER. Mockett, P.; Frisch, D.; Mannelli, I.; Wahlig, M. (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-2098. Rev. Sci. Instrum., 39: 566-70(Apr. 1968).

The details of the construction of a cylindrical spark chamber made from 0.8 mm lead sheets clad with stainless steel foil and subtending a large solid angle are described. Its performance in

the study of the reaction $\pi^+ + p \rightarrow \pi^+ + \pi^0 + p$ is discussed. In particular, the detection efficiency for this reaction, the kinematic resolution resulting from the analysis of the final state angles and the detection efficiency for low energy gamma rays are given. (auth)

24778 LITHIUM INDUCED NUCLEAR REACTIONS AND THE PRODUCTION OF NEGATIVE LITHIUM IONS. Middleton, R.; Adams, C. T.; Bethge, K. (Univ. of Pennsylvania, Philadelphia). Nucl. Instrum. Methods, 61: 115-16(Apr. 15, 1968).

Lithium induced nuclear reactions in the energy range available with electrostatic accelerators provide a useful tool in nuclear structure studies. An easy method is described for obtaining large currents of negative charged lithium ions for tandem Van de Graaff accelerators. (auth)

24779 USE OF TRIODE ION PUMPS FOR PUMPING DEUTERIUM. Post, R. J. (Hammersmith Hospital, London). Nucl. Instrum. Methods, 61: 108(Apr. 15, 1968).

The thermal instability of triode ion pumps when pumping deuterium can be minimized by operating the pumps at reduced voltage. (auth)

24780 THE 2.5 GeV ELECTRON SYNCHROTRON OF THE UNIVERSITY OF BONN. Althoff, K. H.; Baetzner, K.; Drees, J.; (and others) (Univ., Bonn). Nucl. Instrum. Methods, 61: 1-30 (Apr. 15, 1968).

From 1963 to 1967 a 2.5 GeV electron synchrotron with 50 Hz repetition rate has been built at the University of Bonn. Design, construction and first operation of the machine are described. Electrons are injected by a 25 MeV linear accelerator. The magnet ring has a mean radius of 11.08 m and consists of 12 magnets with the basic structure O/2 F D O/2. The frequency of the rf acceleration system is 499.670 MHz. A pure ceramic vacuum chamber is used. To achieve a high circulating beam current a special rf amplitude regulation system has been built to reduce the influence of beam loading. The maximum circulating beam intensity achieved up to now is 5×10^{12} electrons/sec. About 60% of the circulating electron beam can be ejected with spill times up to 1 msec. (auth)

24781 CROSSED-FIELDS ARRANGEMENT FOR USE IN AN ELECTRON–POSITRON g-FACTOR COMPARISON EXPERIMENT. Galbraith, I. A.; Gardiner, R. B. (Univ. of Glasgow). J. Phys., A, 1: 194-202(Mar. 1968).

The motion of relativistic electrons close to the xy plane when subjected to static magnetic and electric fields $(0, 0, B_0)$ and $(0, E_0(1 - ay), E_0az)$ is analysed, B_0, E_0, and a being positive constants. The focusing properties of the fields are investigated, and an expression is derived for the drift velocity of the particles in the direction of the positive x axis. The dependence of the latter quantity on the initial direction of motion and on the energy of the particles is discussed. Finally, the practical realization of the required electric field is considered. Throughout, the relevance of the analysis to the authors' electron–positron g-factor comparison experiment is emphasized. (auth) (UK)

24782 USKORITELI. VYPUSK IX. MOSKOVSKII ORDENA TRUDOVOGO KRASNOGO ZNAMENI INZHENERNO-FIZICHESKII INSTITUT. (Accelerators. Volume IX. Collection of Articles of the Moscow Institut of Physics Engineering). Val'dner, O. A. (ed.). Moscow, Atomizdat, 1967. 220p.

Thirty-two articles are included on the new methods for calculating linear accelerator waveguide parameters, electron beam properties, and high-frequency characteristics of beam channels. Graphs are given for selecting optimum dimension stages for iris-loaded waveguides and accelerated beam parameters for high-energy synchrotron. Dynamics of ultrarelativistic particles in high-frequency separators and problems in computing equivalent deflecting field are discussed. Graphs for separator waveguide calculations based on experimental data are included. Data on modulators and pulsing devices are covered in the last several articles. (R.V.J.)

24783 METHOD FOR EXCITING A CHARGED-PARTICLE DEFLECTING ELECTROMAGNET OF THE PULSE-EXCITATION TYPE. Fujita, Hyota (to Mitsubishi Atomic Power Industries, Inc.). Japanese Patent 1967-12038. July 8, 1967. Filed Apr. 28, 1965.

A method is proposed whereby a single electromagnet can be used for charged-particle deflection and also for measurements of the charged-particle energy and current. Furthermore, the construction is simple and economical. A charged-particle deflecting electromagnet is excited by the pulsed current, which is synthesized from a plurality of the different pulsed-currents. (NSA of Japan)

24784 BUNCHER. Fujita, Hyota (to Mitsubishi Atomic Power Industries Inc.). Japanese Patent 1967-7758. Mar. 29, 1967. Filed Apr. 28, 1965.

An improved buncher is proposed for a linear ion accelerator. The advantages of the method are no disturbance of an electromagnetic field produced in it; no destruction of a high vacuum of the buncher; easy, definite tuning; and simple construction. It consists of the buncher body, which is a cylinder with end plates; a convex electrode having a central ion-beam exit hole, in connection with the inner side of the end plate, which penetrates the end plate so as to be able to move along the ion-beam axis; and the flexible seals which permit the said movement and hence the relative displacement of the electrode and which keep the air-tightness of the buncher. (NSA of Japan)

PHYSICS (NUCLEAR)

Neutron Interactions with Matter

Refer also to abstracts 23292, 24757, 24835, and 25129.

24785 (BNL-12372) TEMPERATURE DEPENDENCE OF QUASI-ELASTIC SCATTERING OF COLD NEUTRONS FROM LIQUID ARGON. Andrus, W. S.; Muether, H. R. (Brookhaven National Lab., Upton, N. Y. State Univ. of New York, Stony Brook); Palevsky, Harry (Brookhaven National Lab., Upton, N. Y.). Apr. 9, 1968. 12p. (CONF-680501-2). Dep. CFSTI.

From Symposium on Inelastic Neutron Scattering, Copenhagen, Denmark.

The scattering of Be-filtered neutrons from liquid Ar at temperatures of 87, 97, 111, and 124°K and at scattering angles of 45, 65, and 80° was investigated. The quasielastic width was obtained as a function of the reciprocal of the temperature. The quasielastic widths were compared with the predictions of Singwi's model (Phys. Rev., 13: A969(1964)) for coherent scattering from liquids. (D.C.W.)

24786 (CONF-670502-, pp 297-306) NEUTRON SCATTERING FROM PARAMAGNETIC TERBIUM. Cable, J. W.; Collins, M. F.; Woods, A. D. B. (Atomic Energy Research Establishment, Harwell (England)).

The energy distribution of neutrons scattered from a single crystal of terbium at about 660°K (T_N = 230°K) was studied as a function of momentum transfer (Q). The measurements were carried out using both the twin rotor time-of-flight spectrometer and the triple axis spectrometer at Harwell. The distributions were approximately Gaussian in shape with an additional tail, which is believed not to be connected with the paramagnetic scattering but more likely with multiple or phonon scattering. The second moments of the energy distribution, as determined from fitted Gaussian curves, yield exchange interactions that are consistent with those deduced from the spin wave dispersion curves in the ferromagnetic state as measured by Moller and Houmann. The distributions contain a large Q independent component, which arises from the anisotropy energy. Typical values of $(\langle\hbar^2\omega^2\rangle)^{\frac{1}{2}}$ near zone boundaries are ~3.2 MeV. (auth)

24787 (GA-8536) DECAY OF A NEUTRON PULSE IN A FAST NONMULTIPLYING SYSTEM AS AN INTEGRAL CHECK ON THE HIGH ENERGY INELASTIC SCATTERING. Gozani, Tsahi; d'Oultremont, P. (Gulf General Atomic, Inc., San Diego, Calif.). Feb. 13, 1968. Contract AT(04-3)-167. 15p. (CONF-680307-30). Dep. CFSTI.

From 2nd Conference on Neutron Cross Sections and Technology, Washington, D. C.

The early time behavior of the neutron population in a pulsed sphere of highly depleted uranium (50.8 cm dia) was measured with ^{237}Np solid-state threshold fission detector. The decay, measured with one nsec time resolution, showed an apparent exponential behavior over a relatively large time range. The measured decay was by no means asymptotic, as demonstrated by the fact that the decay constant was $5.9 \pm 0.2 \times 10^7$ sec^{-1} at R = 11.7 cm, and $4.62 \pm 0.15 \times 10^7$ sec^{-1} at R = 17.8 cm. Furthermore, the decay at times longer than 100 nsec loses its exponential feature. A simple multigroup Monte Carlo code, BN-MOC, was used to compute the time response of the detector. Fairly good agreement with the measurement was obtained by using the measured target source, highly anisotropic scattering and the ENDF/B cross sections for ^{238}U. Additional calculations demonstrated the large sensitivity of the decay to variations in the inelastic scattering cross section of ^{238}U. Similar variations had a smaller effect on the steady state spectrum. The experimental and calculational results have shown the feasibility of using these techniques as a sensitive integral check on inelastic scattering in the low MeV energy range. (auth)

24788 (IA-1128, pp 55-77) NUCLEAR CHEMISTRY. (Israel Atomic Energy Commission, Tel Aviv).

Developments are reported for studies on: low-lying levels of ^{21}Ne; lifetimes of nuclear levels by observation of Doppler-Broadening attenuation using a Ge(Li) gamma spectrometer; ^{17}N delayed neutron spectrum; loop experiments with an emanation source; electric scattering of particles by spherical potentials of the form $V(r) = (A_1/r^{s_1}) + (A_2/r^{s_2})$; elastic scattering of spherical atoms with finite radii by spherical potentials; high-energy chemical reactions in gaseous phase; determination of independent yields of ^{131}I and ^{133}I in thermal neutron fission of ^{235}U by selective recoil labeling; continuous separation of short-lived iodine isotopes; Soreq On-Line Isotope Separator (SOLIS); absolute calibration of neutron sources by manganese sulfate bath method; measurement of exit time of a fast "Shuttle Rabbit" using short-lived radioactivity; use of x-ray spectrometry in activation analysis for determining bromine; analysis of bromine in wood by x-ray counting; activation analysis by counting photoneutrons; preparation of dilute analytical standards of U; and precision and accuracy of U analysis by delayed neutron counting. (P.C.H.)

24789 (ITF-67-45) INELASTIC SCATTERING OF SLOW NEUTRONS IN IMPERFECT FERROMAGNETIC CRYSTALS. Dzyub, I. P. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1967. 34p. Dep.

The differential cross section of inelastic scattering of slow neutrons in imperfect ferromagnets at small concentration of the impurity magnetic atoms is calculated. The technique developed makes it possible to account for the dynamics of the impurity atom surrounded by the crystal host atoms. The contribution of the quasilocalized and localized spin excitations to slow neutron scattering is investigated. The temperature dependence of the one-magnon peak of coherently scattered neutrons is studied as well as the character of noncoherent neutron scattering. The numerical evaluations are given for solid solution of Mn in Fe. (auth)

24790 (LA-3873) LARCA: A FORTRAN-IV CDC-6600 PROGRAM FOR CALCULATING FLUX-WEIGHTED CROSS SECTIONS. Anderson, R. C. (Los Alamos Scientific Lab., N. Mex.). Dec. 29, 1967. Contract W-7405-eng-36. 15p. Dep. CFSTI.

A FORTRAN-IV, CDC-6600 program, LARCA, which computes flux-weighted cross sections for homogeneous or heterogeneous mixtures of materials, is described. The program also computes infinite medium fluxes, reaction rates, and other related quantities. The flux-weighted cross sections are punched in a form suitable for use in the multigroup transport theory program DTF-IV. (auth)

24791 (TRG-Report-1568) ACCURATE SOLUTION OF TRANSPORT THEORY PROBLEMS BY THE USE OF A NEW VERSION OF DIFFUSION THEORY. Ackroyd, R. T. (United Kingdom Atomic Energy Authority, Risley (England). Reactor Group). Nov. 1966, Reprinted 1968. 49p. Dep. CFSTI. UK 7s.

Declassified reprint of TRG-Memo-3718.

Each group of a transport theory model is treated so that each group equation and its associated boundary conditions are replaced by spherical harmonic equations, of an odd order for the moments of the angular flux, and the associated boundary conditions for the moments. The moment equations and boundary conditions are then cast into a form with the appearance of a generalized version of multigroup diffusion theory. The even moments correspond to the group fluxes of diffusion theory in this analogy. The gradients of the even moments correspond to the net group currents of diffusion theory. At an interface the moments, i.e., the analogous group fluxes, are continuous, and if the scattering is isotropic the product of the gradient of an analogous group flux and the diffusion coefficient of diffusion theory is continuous. The principal application foreseen for the analogy is in the transport theory calculations. This version of transport theory (in the mold of multigroup diffusion theory) can be used in areas where classical diffusion theory fails, and it can be grafted onto classical diffusion theory in areas where the latter is adequate. This method for transport theory calculations is illustrated by an analytical treatment of boundary transients at the interface of a core and reflector. The method is probably of greatest interest for numerical work. For example, a 16-energy-group transport calculation by the method of the effect of a grey control rod requires, in effect, a 16-group classical diffusion theory calculation away from the rod and $16[(M + 1)/2]$-group diffusion theory calculation for the rod and its neighborhood, when M spherical harmonics are used for the angular flux in the rod. The method is of some interest because it suggests a way in which transport theory calculations on a reactor might be accomplished with very little more expenditure of machine time than is required for diffusion theory calculations. (auth)

24792 (WANL-TME-1680) STATUS REPORT ON THE CONVERSION (FOR A CDC 6600 COMPUTER) OF THE TWO DIMENSIONAL TRANSPORT PROGRAM DOT. Collier, G.; Gibson, G.; Soltesz, R. G. (Westinghouse Electric Corp., Pittsburgh, Pa. Astronuclear Lab.). Sept. 1967. Subcontract NP-1. 44p. Dep. CFSTI.

A FORTRAN-IV, IBM 7094, version of the two-dimensional Discrete Ordinates Transport code (DOT) which was developed

at the Oak Ridge National Laboratory by the Union Carbide Corporation has been converted for use on the CDC 6600 computer. In addition, options have been added to allow cross sections which are punched in a 6E12.5 FORTRAN format as well as decimal cross sections for ODD-K to be read by the DOT program. In this report, results of r-z and r-θ geometry calculations that have been obtained with the converted DOT program are presented, and some comparisons are made with results obtained with the ODD-K and DDF programs utilizing the same input parameters. In making these comparisons, a discrepancy has been observed in the solution of the fast flux at the outer (right) boundary in the DOT program. This discrepancy occurs only when the negative flux correction option is used in DOT for the flux calculation. This option for the difference equations is not available in WANL's version of DDF nor is it available in ODD-K. In collaboration with the Oak Ridge Personnel, this discrepancy is being resolved. Because there are aspects of the code that have not yet been investigated, this study of the converted DOT program is considered preliminary in nature. However, the status of the program is such that calculations of complex problems with various mesh and convergence criteria, etc., can now be attempted. Various design groups at WANL are at present initiating such studies. (auth)

24793 (WANL-TME-1751) GAMB1T USER'S MANUAL. Gray, W. H.; Collier, G. (Westinghouse Electric Corp., Pittsburgh, Pa. Astronuclear Lab.). Feb. 1968. Subcontract NP-1. 233p. Dep. CFSTI.

The program GAMB1T was designed to calculate multigroup cross sections in the high-energy and thermal ranges. Input instructions, input and output for a sample problem, and a FORTRAN listing of the program are presented. (D.C.W.)

24794 CALCULATION OF THE EFFECTIVE RESONANCE INTEGRALS VIA TRANSMISSION. Collatz, S. (Zentralinstitut fuer Kernphysik, Rossendorf, Ger.). Kernenergie, 11: 1-3(Jan. 1968). (In German).

The homogeneous effective resonance integrals in the keV energy region were calculated on the basis of the statistical distribution of resonance parameters via transmission of a neutron beam through a layer of variable thickness taking into account the overlapping of resonances. The special form of the function to be integrated of the transmission integral makes possible a strong reduction of the number of integrations and, consequently, an essential reduction of the volume of numerical computations. (auth)

24795 CONTRIBUTION TO THE ALBEDO PROBLEM OF NEUTRON TRANSPORT FOR A SLAB. Kiesewetter, H.; Kruse, R. (Univ., Rostock, Ger.). Kernenergie, 11: 3-10(Jan. 1968). (In German).

The use of the Fourier transformation method gives a finer representation of the total flux $\Phi(x)$ as compared to the treatment of albedo problem known so far. In numerical evaluation of the results for a large interval of parameters, splitting of the solution into an asymptotic part $\Phi_{as}(x)$ and a transport part $\Phi_{tr}(x)$ is studied in detail. For nearly parallel particles $\Phi_{as}(x) < \Phi(x)$; but for perpendicularly incident particles $\Phi_{as} > \Phi(x)$. (auth)

24796 NUMERICAL SOLUTION OF THE BOLTZMANN TRANSPORT EQUATION. Lathrop, K.; Carlson, B. (Los Alamos Scientific Lab., N. M.). J. Comput. Phys., 1: 173-97(Nov. 1966).

A numerical model for solution of the linear Boltzmann transport equation is formulated. By applying the same techniques used in the derivation of the analytic equation, a discrete analog of the Boltzmann equation is derived for a finite cell in phase space. Initially undetermined coefficients in the analog are determined by requiring the numerical formulation to include properties (e.g., particle conservation) of the analytic equation. Terms occurring in the finite-cell analog are defined, and two treatments of the angular dependence are illustrated. A discrete ordinates representation is derived based on a connected straight-line-angular representation. This formulation maintains optical reciprocity and may be generalized. The systematic derivation of difference relations necessary to complete solution of the numerical formulation is described. Both representation schemes, based on assumed forms of particle fluxes in the cell, and characteristic schemes are examined. Difficulties encountered in extrapolations made by the use of representation schemes are clarified, and insight is gained for methods that can be used to prevent flux oscillations in numerical calculations. (auth)

24797 NEUTRON SCATTERING FROM AN n-DIMENSIONAL LATTICE (n = 1,2,3). Kothari, L. S. (Univ. of Delhi); Goyal, I. C. Phys. Rev., 168: 752-4(Apr. 15, 1968).

It is known that the phonon expansion method, which is extensively used to calculate neutron scattering cross sections from isotropic solids, breaks down for linear and layer lattices. It is shown that, in the incoherent approximation, one can calculate the scattering law for the latter two cases by properly summing over the multiphonon processes. Some typical results are reported. (auth)

24798 STUDY OF TRANSIENT NEUTRON SPECTRA IN BERYLLIUM ASSEMBLIES. Goyal, I. C. (Univ. of Delhi); Kothari, L. S.; Ghatak, A. K. Proc. Nat. Inst. Sci. India, Part A, 33: 38-65(Mar. 1967).

The results of an extensive series of calculations to understand quantitatively the approach to equilibrium of a neutron pulse in finite beryllium assemblies are reported. The theoretical results are compared with experiments, and the agreement is very good. The thermalization time was also calculated, and the possibility of determining it is discussed. The theoretical values are compared with the recent experimental values, and the agreement is satisfactory. Diffusion theory was used throughout in making the calculations. (auth)

24799 AUTOMATIC REDUCTION OF CROSS-SECTION CURVES INTO A SUM OF BREIT-WIGNER TERMS. Nifenecker, H.; Perrin, G.; Audias, A. (CEN, Saclay, France). Nucl. Instrum. Methods, 61: 198-204(May 1968). (In French).

A curve stripping program is applied to the neutron cross-section curves. It automatically gives the parameters of the resonances even if they are not clearly defined. (auth)

24800 BIORTHOGONAL ANGULAR POLYNOMIAL EXPANSION OF THE TWO-DIMENSIONAL TRANSPORT EQUATION. Lathrop, K. D. (Gulf General Atomic Inc., San Diego, Calif.); Demuth, N. S. Nucl. Sci. Eng., 32: 120-30(Apr. 1968).

A new system of biorthogonal polynomials is developed for the angular expansion of the directional flux in the linear Boltzmann transport equation. It is shown in systems infinite in one space dimension that the angular integral in the Boltzmann equation can be reduced to a weighted integral over the unit circle. The corresponding system of orthogonal functions is found to be a system of two sets of polynomials in two variables. Recursion relations and an addition theorem are derived for these polynomials. The angular dependence of the particle flux is expanded in each set of these polynomials. Systems of partial differential equations are derived for the expansion coefficients, that is, for angular moments of the particle flux. One of these systems is shown to be a specific linear combination of the equations obtained when the directional flux is expanded in the spherical harmonics functions specialized for the geometry considered. It is shown that this same system, in (x, y) geometry, reduces simply to the spherical harmonics equations in one-dimensional plane geometry. (auth)

24801 NEW SYNTHESIS METHOD FOR PULSED-NEUTRON EXPERIMENTS. Devooght, J.; Machgeels, C. (Univ. Libre, Brussels). Nucl. Sci. Eng., 32: 82-92(Apr. 1968).

A new method of synthesis of the time-dependent behavior of a neutron pulse or of the space-dependent transfer function is given which combines analytical time dependence with numerical (or analytical) dependence of the other variables. The analytical development in Laguerre polynomials of time is obtained recursively in solving iteratively the static Boltzmann equations with sources. The convergence of the development, the bound of the truncation error, and the choice of the free parameters are examined for various cases. The method is finally applied (using an experimental map of the steady flux) in a water slab and the synthesized time-dependent flux is compared to the experimental one. (auth)

24802 EXTENSIONS OF ASYMPTOTIC NEUTRON DIFFUSION THEORY. Winslow, Alan M. (Univ. of California, Livermore). Nucl. Sci. Eng., 32: 101-10(Apr. 1968).

A formulation of asymptotic neutron diffusion theory for numerical calculations is presented which provides in simple ways for physical features not included in the elementary form of the theory. These are: (1) exponential time dependence, which is provided for by a transformation to steady state; (2) effect of surface curvature on the linear extrapolation length, provided for by means of the principal radii of curvature; (3) material discontinuities, provided for by limiting the current at an interface to its free surface value; and (4) prescribed sources and velocity dependence, provided for by a generalization of the number of secondary neutrons per collision. Numerical results are presented showing that the form of time-dependent multigroup neutron diffusion theory thus obtained is more accurate than the ordinary multigroup formulation especially for small or inhomogeneous systems. (auth)

24803 MAGNETICALLY PULSED NEUTRON BEAM FOR TIME-OF-FLIGHT MEASUREMENTS OF INELASTIC SCATTERING. Mook, H. A.; Wilkinson, M. K. (Oak Ridge National Lab., Tenn.). J. Appl. Phys., 39: 447-9(Feb. 1, 1968).

In many types of experiments, time-of-flight neutron spectrometers have the advantage of higher counting rates than crystal spectrometers, especially in view of the fact that multiple counters may be used. A method of magnetically pulsing a neutron beam

was developed that avoids the necessity of using high-speed rotating equipment. The magnetic intensity in a Bragg reflection depends on the orientation of the atomic magnetic moments relative to the scattering vector, and it becomes zero when the moments are directed along the scattering vector. The direction of magnetization in ferrite crystals can be switched rapidly with an external magnetic field so that these crystals can serve both as a neutron monochromator and pulser. Furthermore, the neutron pulse-width and repetition rate can easily be varied by changing the current pulse that produces the external field. The nuclear contribution for the (111) or (331) reflections can be made very small for ^{7}Li–Ti ferrite of the correct composition. Large magnetic scattering intensities can be obtained in each case. The pulsed magnetic field is produced by switching the energy stored in a pulse-forming network into a magnet-drive coil by means of a silicon controlled rectifier. The pulse rise time is about 1 μsec and the pulse length in the present instrument is 12 μsec. (auth)

24804 INELASTIC SCATTERING OF NEUTRONS BY VIRTUAL MAGNON STATES IN DILUTE ALLOYS. Kroo, N.; Pal, L. (Central Research Inst. for Physics, Budapest). J. Appl. Phys., 39: 453-4(Feb. 1, 1968).

The effect of weakly bound magnetic impurity atoms (Mn, Er) on the spin-wave spectrum of Fe was studied by incoherent inelastic neutron scattering. Resonances of magnetic origin were observed in both cases. In Fe–Mn the angular distribution of the total scattered intensity has a maximum, indicating that $S_{Mn} \neq 0$ and the density distribution of magnetic electrons of iron atoms near the Mn impurity has changed. In Fe–Er, a low-lying virtual level of long lifetime was found. (auth)

24805 TEMPERATURE DEPENDENCE OF THE GENERALIZED SUSCEPTIBILITY OF NICKEL. Lowde, R. D.; Windsor, C. G. (Atomic Energy Research Establishment, Harwell, Eng.). J. Appl. Phys., 39: 449-50(Feb. 1, 1968).

The extension to a range of temperatures of our previous work (at 1.6 T_C) on fitting the susceptibility of the free-electron gas to the measured magnetic neutron scattering from a crystal of ^{60}Ni indicates that the exchange enhancement is virtually constant at about a factor of three from 1.05 T_C to 2.3 T_C. (auth)

24806 TEMPORAL FLUCTUATIONS OF MOMENT IN PARAMAGNETS BY NEUTRON DIFFRACTION. Collins, M. F. (Atomic Energy Research Establishment, Harwell, Eng.). J. Appl. Phys., 39: 533-7(Feb. 1, 1968).

The inelastic scattering of neutrons by temporal fluctuations of spin in a paramagnet is reviewed. The scattering cross section is directly proportional to the imaginary part of the generalized frequency and wavelength-dependent susceptibility of the scattering material. For localized spins the theory of the scattering is discussed both in terms of exact solutions for the susceptibility in the few cases where this is known and in terms of the moments of the susceptibility. Experimentally the technique provides good measurements of exchange constants at high temperatures for insulators and for rare earth metals where the magnetic electrons are localized. In transition metals the form of the susceptibility is modified by the itinerance of the magnetic electrons and this is reflected in the experimental data. Exchange and correlation effects will enhance the low-frequency component of the susceptibility over that predicted for a noninteracting electron gas. The experimental data available appear to confirm the existence of such enhancement effects. (auth)

24807 NEUTRON-SCATTERING STUDIES OF CRITICAL MAGNETIC PHENOMENA. Riste, T. (Institutt for Atomenergi, Kjeller, Norway). J. Appl. Phys., 39: 528-32(Feb. 1, 1968).

Neutron-scattering studies of critical magnetic fluctuations are reviewed. By comparison with theoretical predictions, it is concluded that the spatial dependence of critical fluctuations and the temperature laws of their parameters are rather well in hand. For the time dependence of the fluctuations the situation is less clear, although two experiments, which are referred to, give evidence for a vanishing decay parameter at T_c, in agreement with theory. The question of the simultaneous existence of spinwaves and critical fluctuations is qualitatively discussed, and experiments bearing on this question are mentioned. (auth)

24808 RECIPROCITY PROPERTIES OF ADJOINT KERNELS IN THE MULTIGROUP AND AGE MODEL. Breitenhuber, L. (Technische Hochschule, Graz). Atomkernenergie, 13: 125-9 (1968). (In German).

Empirically found analogies between the fast adjoint flux and the thermal flux are traced back to rigorous reciprocity theorems. For arbitrarily space dependent cross sections a symmetry relation between convolution diffusion kernels and their adjoints is derived. For homogeneous finite regions and point sources it is proved that the thermal flux and the fast adjoint flux are identical in their space dependence. The used bilinear expansions can be applied to prove an extension of the second fundamental theorem of reactor theory. (auth)

24809 MAGNETIC NEUTRON SCATTERING FROM ATOMS DISSOLVED IN FERROMAGNETIC IRON AND NICKEL. Low, G. G. (Atomic Energy Research Establishment, Harwell, Eng.). J. Appl. Phys., 39: 1174-80(Feb. 1, 1968).

Recent experimental results giving the distribution of the magnetic-moment disturbance associated with solute atoms in ferromagnetic Fe and Ni are summarized. The disturbances around transition elements dissolved in iron are of two quite different forms dependent on whether the element concerned lies to the right or to the left of iron in the periodic table. This suggests a dependence on the sign of an electrostatic perturbing potential and a discussion of this possibility is given in terms of a simple electron gas model. The two types of magnetic disturbance observed are not related by a sign reversal and the nonlinearity thus demanded by experiment is thought to result from limitations on electron-density increases imposed in iron by the restricted number of orbitals available at any one site. Experimental results for Fe alloys containing nontransition-element solutes are also examined. Measurements on a wide range of both transition and nontransition elements dissolved in Ni are reviewed. Zn, Al, Ga, Si, Ge, Sn, Sb, V, Cr, Nb, Mo, Ru, W, and Re all result in a widespread loss of magnetic moment from the Ni host surrounding a solute site. The magnetic disturbances corresponding to these impurities differ in magnitude but show an approximately invariant shape. These defects are discussed in terms of bound impurity states and a molecular-field treatment involving a nonlocal and nonlinear susceptibility to represent the magnetic properties of Ni. (auth)

24810 NEUTRON-DIFFRACTION DATA ON Ti_2O_3 AND V_2O_3. Kendrick, H. (Univ. of Michigan, Ann Arbor); Arrott, A.; Werner, S. A. J. Appl. Phys., 585-7(Feb. 1, 1968).

Without considerable care one might conclude from neutron-diffraction studies of Ti_2O_3 and V_2O_3 that these materials are antiferromagnetic. The problem is that multiple-Bragg scattering can masquerade as small superlattice reflections. A large and rapid change in the intensities at the superlattice positions was noted when the crystal was tilted about the scattering vector, indicating multiple scattering. The intensities of these reflections relative to the nuclear reflections decrease with increased collimation. In order to reduce this source of scattering, a 2.09 Å beam was used instead of the usual 1.07 Å neutrons. Energy analysis of the beam reflected from the superlattice positions gives the result that there is essentially no real magnetic scattering at either the (111) or the (100) in Ti_2O_3. An upper limit of 0.01 μ_B to Néel-type antiferromagnetism can be assumed. Investigations of a single crystal of V_2O_3 above the phase transition (~150°K) were subject to the same problems. However, below the transition, the mosaic structure of the crystal increased (indicating that the crystal was broken up) and there remained no detectable intensity at the superlattice positions. (auth)

24811 PROTON MOTIONS IN SOME HYDROGENOUS LIQUIDS BY NEUTRON SCATTERING CROSS-SECTION MEASUREMENTS. Rapeanu, S.; Iliescu, N.; Preda, I. M. (Inst. of Atomic Physics, Bucharest). Rev. Roum. Phys., 12: 943-9(1967).

Neutron scattering cross-sections (per proton) for pentane, amyl alcohol, glycerine, and methyl alcohol in the region of 3 to 8 Å were measured by a crystal spectrometer at room temperature. The cross-sections were plotted versus the neutron wavelength and the slopes were derived. The results give evidence on the hydrogen atom contribution to the methylene groups and on the hindrance of the OH groups or group on the molecule rotation. (auth)

24812 MAGNETIC SCATTERING OF NEUTRONS IN MnF_2 NEAR THE CRITICAL POINT. Parette, G.; Deniz, K. Usha (Centre d'Etudes Nucleaires de Saclay, Gif-sur-Yvette, France). J. Appl. Phys., 39: 1232-4(Feb. 1, 1968).

The angular distribution of slow neutrons (γ = 4.34 Å) scattered from a single crystal of MnF_2 was studied as a function of temperature in the vicinity of the Néel point, about the (100) and the (001) reciprocal lattice points. The (001) data were analyzed to obtain the values of $\chi_{\perp\perp}$, the transverse staggered susceptibility, and its variation with temperature above the transition point was examined in the light of the theories of Moriya and Tomita. Moriya's theory shows that $\chi_{\perp\perp}$ is proportional to $(T-T_J)^{-1}$, where (T_N-T_J) is calculated by him to be 1.36°K. To give a good fit to values obtained, an expression of the type $(T-T_J)^{-\gamma}$ was used for $\chi_{\perp\perp}$ with Moriya's value for (T_N-T_J), and γ is found to be 0.85. A much better fit is obtained by using the expression for $\chi_{\perp\perp}$ suggested by Tomita, namely, $C\{A + B(T-T_N)^{\gamma}\}^{-1}$, for A = 0.016 and γ = 1.22. The longitudinal staggered susceptibility, $\chi_{\parallel\parallel}$, has been deduced from the measurements around the (100) point. Its temperature dependence

above T_N is found to be of the form $(T - T_N)^{-1}$, and is not consistent with a four-thirds power law. (auth)

24813 CRITICAL SCATTERING OF NEUTRONS FROM TERBIUM. Als-Nielsen, J. (Riso Research Establishment, Roskilde, Denmark); Dietrich, O. W.; Marshall, W.; Lindgard, P. A. J. Appl. Phys., 39: 1229-30(Feb. 1, 1968).

The inelasticity of the critical scattering of neutrons in Tb was measured above the Neél temperature at the (0,0,2−Q) satellite position. The results show that dynamic slowing down of the fluctuations does occur in a second-order phase transition in agreement with the general theory. However, the detailed variation of the inelasticity with temperature is in disagreement with existing theories, and it is concluded that the conventional theory is invalid except at infinite temperatures. (auth)

24814 CRITICAL MAGNETIC SCATTERING OF NEUTRONS IN CHROMIUM. Hamaguchi, Y. (Japanese Atomic Energy Research Inst., Tokyo); Tsunoda, Y.; Kunitomi, N. J. Appl. Phys., 39: 1227-8(Feb. 1, 1968).

The magnetic properties of the metallic Cr can be interpreted in terms of itinerant electron model. The angular distribution of the neutron diffuse scattering around its (1δ0) satellite reflection was measured with the temperature of $T_N - 20°C \leq T \leq T_N + 33°C$. Improvement of the instrumental resolution has made it possible to observe the correlation range more accurately and to determine its anisotropic property. Correlation range of the spin system above the Néel temperature, which was analyzed from the experimental data on the basis of the Ornstein−Zernike-type correlation function and the static approximation, was obtained as $\kappa_{\parallel}^2(Q_{\parallel}) \propto (T - T_N)^{0.70\pm0.2}$ and $\kappa_{\perp}^2(Q_{\perp}) \propto (T - T_N)^{0.54\pm0.2}$. The temperature dependence is remarkably smaller than those obtained in various substances and the theoretical conclusions of Ising or Heisenberg model. (auth)

24815 NEUTRON SCATTERING FROM MAGNETITE BELOW 119°K. Samuelsen, E. J.; Bleeker, E. J.; Dobrzynski, L.; Riste, T. (Institutt for Atomenergi, Kjeller, Norway). J. Appl. Phys., 39: 1114-15(Feb. 1, 1968).

A neutron-scattering experiment to look for spin-wave excitation-energy changes of magnitite at the transition point 119°K showed no such change. During this work we discovered, however, that the low-temperature structure gives rise to weak extra neutron-diffraction lines that can be indexed as (h, k, $1 \pm \frac{1}{2}$) in cubic indices. From the observed neutron polarization sensitivity of the intensities and the increasing structure factors with increasing $\sin\theta/\lambda$, we conclude that the extra reflections are not directly due to magnetic ordering (ferrimagnetic spirals or $Fe^{2+} - Fe^{3+}$ ordering on the octahedral sites). Rather they are caused by a lowering of the crystal symmetry. (auth)

24816 CRITICAL SCATTERING OF THERMAL NEUTRONS IN SOME FERROMAGNETIC METALS. Bally, D.; Grabcev, B.; Popovici, M.; Totia, M.; Lungu, A. M. (Inst. for Atomic Physics, Bucharest). J. Appl. Phys., 39: 459-60(Feb. 1, 1968).

The small-angle critical scattering of 1.25-Å-wavelength neutrons in Fe, Ni, and Co was studied. The temperature shift of the maximum scattered intensity in Fe was determined. The shape of the instantaneous spin correlation function has been deduced from angular distribution measurements of scattered neutrons in Fe and Co. The temperature dependences of the correlation range and magnetic susceptibility for Fe and Co are presented. (auth)

24817 NEUTRON PARAMAGNETIC SCATTERING FROM HOLMIUM AND ERBIUM. Holden, T. M.; Powell, B. M.; Woods, A. D. B. (Chalk River Nuclear Labs., Ont.). J. Appl. Phys., 39: 457-8(Feb. 1, 1968).

The energy distributions of neutrons scattered by polycrystalline Ho and Er and by a single crystal of Ho, in the paramagnetic phase, were studied by time-of-flight and triple-axis-spectrometer techniques at 296°K. The distributions exhibit some dependence on momentum transfer and are not of a Gaussian form. The widths of the distributions for Ho and Er are similar. For polycrystalline Ho at $4\pi\sin\theta/\lambda = 0.5$ Å^{-1} the full width at half-maximum of the energy distribution is ~2.5 MeV, which is three times greater than the largest crystal-field transition predicted on the basis of a simple interpretation of the magnetic-susceptibility data. Experiments on the Ho crystal indicate little difference between the widths of the distributions measured along the a and c axes. None of the experiments reveals the presence of discrete crystal field levels. (auth)

24818 INELASTIC MAGNETIC SCATTERING FROM $RbMnF_3$ IN THE NEIGHBORHOOD OF ITS NÉEL POINT. Nathans, R. (Brookhaven National Lab., Upton, N. Y.); Menzinger, F.; Pickart, S. J. J. Appl. Phys., 39: 1237-8(Feb. 1, 1968). (BNL-11634).

A study of the inelastic neutron scattering from antiferromagnetic $RbMnF_3$ in the vicinity of the Néel point reveals the presence of a diffusive-type peak, accompanied by spin-wave modes that persist above the transition temperature. The width of the diffusive peak for small-momentum transfer is found to be strongly temperature-dependent above T_N, indicating a slowing down of the spin fluctuations near the transition. (auth)

24819 A NEW METHOD OF APPROXIMATION OF THE BOLTZMANN EQUATION. Benoist, Pierre; Kavenoky, Alain (CEN, Saclay, France). Nucl. Sci. Eng., 32: 225-32(1968).

In a new method of approximation of the Boltzmann equation, one starts from a particular form of the equation that involves only the angular flux at the boundary of the considered medium and where the space variable does not appear explicitly. Expansion of the angular flux of neutrons leaking from the medium, in spherical harmonics with no assumption about the angular flux within the medium, gives a very good approximation of several classical plane geometry problems. These problems include the albedo of slabs and the transmission by slabs, the extrapolation length of the Milne problem, and the spectrum of neutrons reflected by a semi-infinite slowing down medium. The method may be extended to other geometries. (auth)

24820 THE C_n METHOD OF APPROXIMATING THE BOLTZMANN EQUATION IN CYLINDRICAL GEOMETRY. Benoist, Pierre; Kavenoky, Alain (CEN, Saclay, France). Nucl. Sci. Eng., 32: 270-1(1968).

The C_n approximation method (Nucl. Sci. Eng., 32: 225(1968)) for the Boltzmann equation was applied to cylindrical geometry problems. The extrapolation length was calculated for a black cylinder surrounded by an infinite scattering and absorbing medium. (D.C.W.)

24821 SPECTRA AND DOSES OF THE NEUTRONS OF INTERMEDIATE ENERGIES IN ABSORBING HYDROGEN-CONTAINING MEDIA. Stanolov, Angel; Khristov, Vasil; Markov, Pavel. Izv. Fiz. Inst. Aneb, Bulg. Akad. Nauk., 16: 165-72 (1967). (In Bulgarian).

The deviation from the spectrum distribution of 1/E upon the slowing down of neutrons in absorbing hydrogen-containing media is investigated. The experiments were carried out with the IRT reactor in Sofia. The spectrum of the neutrons in the energy range of 0.46 eV to 5800 eV, upon their slowing down in paraffin mixed with boric acid, has been measured by means of 13 activation resonance detectors. Curves of the experimentally obtained and theoretically calculated spectrum distributions are shown. These curves are used to calculate the errors made when the real spectrum and its deviation from the law of 1/E is not taken into consideration in calculating the doses of the energy consumed. In the cases investigated these errors are equal to 12 and 14 per cent respectively. Using the photoemulsion method, measurements were also made of the spectrum of the fast neutrons in the neutron beam of the first horizontal channel of the reactor falling on the paraffin cylinders studied. (auth)

Nuclear Properties and Reactions, A≤ 5

Refer also to abstracts 24574, 24689, 24826, 24888, 24911, and 24912.

24822 ABSORPTION OF S-ORBIT π^- MESONS BY ^{4}He. Koltun, D. S. (Univ. of Rochester, N. Y.); Reitan, A. Nucl. Phys., B4: 629-42(1968).

The rate for absorption of s-orbit bound π^- mesons by correlated nucleon pairs, and the distributions in momentum and lab angle of the emitted fast nn or np pair are calculated for ^{4}He. The pion is assumed to be absorbed either directly by one nucleon, or by processes that involve exchange of the absorbed pion between the two nucleons in question. The absorbing nucleon pair is assumed to interact in the initial state through a harmonic-oscillator potential plus a short-range (Hamada−Johnston) interaction, and in the final state only through the short-range interaction. (auth)

24823 ASYMMETRY OF RECOIL NUCLEI IN CAPTURE OF POLARIZED MUONS. Galindo, A.; Pascual, P. (CERN, Geneva). Nucl. Phys., B4: 295-305(1968).

A general theory of the asymmetry parameter is presented for the recoil nucleus after the capture of polarized muons. This theory is applied to the study of the asymmetry parameter in the capture $\mu^- + {}^3\text{He} \rightarrow {}^3\text{H} + \nu_\mu$. (auth)

24824 MEASUREMENT OF SHORT-LIVED DELAYED PHOTONEUTRONS FROM FISSION-FRAGMENT GAMMA RAYS OF ^{235}U IN HEAVY WATER. Onega, R. J.; Forbes, P. W.; Furr, A. K.; Robeson, A. (Virginia Polytechnic Inst., Blacksburg). Nucl. Sci. Eng., 32: 49-55(Apr. 1968).

The kinetic equations for a heavy-water-moderated reactor have terms describing the production of neutrons in the photodisintegration of deuterons. A technique was developed for the measurement of these short-lived delayed-photoneutron groups. A ^{235}U target was placed in the center of a sphere of D_2O and a chopped neutron beam from the VPI reactor was allowed to impinge on the target. The time for a revolution of the chopper varied from 86.4 to 0.463 sec in six steps and there are two pulses per revolution. The ratio of "beam-on" target time to "beam-off" target time is 1 to 16.5. During the beam-off time interval, the production rate of delayed neutron and delayed photoneutrons as a function of time was stored in a time base multichannel analyzer. The half-lives of two new delayed-photoneutron groups were determined to be 7.39×10^{-3} and 4.02×10^{-3} sec with relative abundances of 0.0292 and 0.170, respectively. The relative abundances represent the fractions of the delayed-neutron and delayed-photoneutron groups. (auth)

24825 AXIAL-VECTOR SUM RULE FOR ^3He. Peterson, Earl A. (Univ. of Minnesota, Minneapolis). Phys. Rev. Lett., 20: 776-8(Apr. 1, 1968).

The form factor for the three-nucleon system $^3He-^3H$ is defined by specifying the nuclear matrix element of the axial-vector current, and an attempt is made to calculate the form factor using the procedure of Fubini, Furlan, and Rossetti (Nuovo Cimento, 40A: 1171(1965)). (D.C.W.)

Nuclear Properties and Reactions, $6 \leq A \leq 19$

Refer also to abstracts 23720, 24536, 24788, 24847–24849, 24888, 24895, 24897, 24911, and 24912.

24826 (BNL-12342) PROTON-NUCLEUS SCATTERING. Simpson, W. Dwain (Brookhaven National Lab., Upton, N. Y.). Mar. 13, 1968. 40p. (CONF-680102-3). Dep. CFSTI.

From Meeting of the American Physical Society, Chicago, Ill.

Some scattering experiments that were performed using 1-GeV protons from the Cosmotron are summarized. The resolution that was attained in these experiments is discussed in detail. The results that were obtained for elastic scattering by ^{12}C, D, ^4He, and ^{16}O are presented, and the analysis of the data is outlined. (D.C.W.)

24827 (JINR-P15-3756) UPRUGOE RASSEYANIE TRITONOV NA KISLORODE V INTERVADE ENERGII 0,9–1,7 MeV. (Elastic Scattering of Tritons by Oxygen in the Energy Range 0.9 to 1.7 MeV). Kobzev, A. P.; Salatskii, V. I.; Telezhnikov, S. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Neutron Physics). 1968. 19p. (In Russian). Dep.

Elastic scattering of tritons by oxygen at the angles of 79.5, 115.5, 133, 144, and 150° in the laboratory system was investigated. The scattering is found to differ from that calculated according to the Rutherford formula. Anomalies, which can be connected with the resonances in the excitation functions of the reactions $^{16}O(t,\alpha)^{15}N$ and $^{16}O(t,p)^{18}O$, are observed in all the scattering curves. (auth)

24828 METHOD OF DEFORMED ORBITS AS APPLIED TO LIGHT NUCLEI. Vashakidze, I. Sh.; Mamasakhlisov, V. I. (Tbilisi State Univ., USSR). Yadern. Fiz., 7: 303-8(Feb. 1968). (In Russian).

Excited bound states of the nuclei with $A = 6$ and the β decay of the ^6He nucleus are calculated by the method of deformed orbits. The interaction between nucleons is taken as a real interaction. A reasonable agreement with experiment is obtained. (auth)

24829 REACTION (π^+,NN) AND TWO-HOLE EXCITATIONS OF LIGHT NUCLEI. Kopaleishvili, T. I.; Machabeli, I. Z.; Gogsadze, G. Sh.; Krupennikova, N. B. (Tbilisi State Univ., USSR). Yadern. Fiz., 7: 292-7(Feb. 1968). (In Russian).

Reactions (π^+,NN) on nuclei ^{16}O, ^{14}N and ^{12}C with excitations of some levels of the residual nuclei are investigated. The calculations are carried out for two values of the incident π^+ meson energy: E_π equals to 40 and 100 MeV. The results are compared with available experimental data. (auth)

24830 INVESTIGATION OF CHARGED PRODUCTS FROM ELECTRODISINTEGRATION OF ^9Be AND CARBON. Borzhkovskii, V. F.; Cherkasov, A. S.; Afans'ev, N. G.; Grishaev, I. A.; Zalyubovskii, I. I. (Kharkov State Univ.). Yadern. Fiz., 7: 261-3(Feb. 1968). (In Russian).

Yields of charged products from the electrodisintegration of ^9Be and carbon (polyethylene) at the electron energy 110 to 119 MeV were investigated by means of a magnetic spectrometer, semiconductor counter, and amplitude impulse analyzer at an angle of 76°. The yield was observed in channels corresponding to the ions with $A = 4$, $Z = 1$ and $A = 5$, $Z = 1$. For carbon the differential cross section of the yield of particles with energy 1.06 MeV in the 5^{1+} canal under the angle of 76° equals to $\sim 2 \times 10^{-33}$ cm^2/sterad · MeV. (auth)

24831 NUCLEAR MAGNETIC TRANSITIONS IN ^9Be BY INELASTIC ELECTRON SCATTERING AT 180°. Vanpraet, G. J.; Barber, W. C. (Stanford Univ., Calif.). Z. Phys., 211: 213-17 (1968).

Transitions with magnetic character were observed in $^9Be(e,e')$ at 180° with 58-MeV primary electrons. Strong peaks occur at excitation energies of 2.4, 8.0, 9.0, 10.2, 11.8, 14.3, 16.3, 16.9, 18.5 and in the giant resonance region between 20 and 26 MeV. The momentum transfer dependence of the 2.4-MeV excitation was investigated with 42.5-, 58-, and 68-MeV incident electrons. (auth)

24832 NEW THICK-TARGET TECHNIQUE FOR CHARGED-PARTICLE RADIATIVE CAPTURE STUDIES. Blatt, S. L.; Nichols, D. B.; Arns, R. G.; Goss, J. D.; Hausman, H. J. (Ohio State Univ., Columbus). Nucl. Instrum. Methods, 61: 232-4 (May 1968).

A technique is described wherein radiative capture cross sections can be measured over a wide range of energies, in a single run, using thick targets and high-resolution gamma-ray detectors. Results from $^{12}C(p,\gamma)^{13}N$ are presented. (auth)

24833 FISSION-SPECTRUM-AVERAGED CROSS-SECTION MEASUREMENT FOR THE $^9Be(n,2n)$ REACTION. Green, L. (Bettis Atomic Power Lab., West Mifflin, Pa.). Nucl. Sci. Eng., 32: 30-4(Apr. 1968).

A manganese sulfate bath technique was used to make an accurate measurement of the $^9Be(n,2n)$ cross section averaged over a pure ^{252}Cf spontaneous fission-neutron spectrum. Monte Carlo calculations were performed to correct precisely for spectrum distortion due to elastic scattering in the Be. Corrections were also made for all other competing reactions of importance. The result obtained, 144 ± 6 mb, is in good agreement with the value of 150 mb calculated from an excitation curve based on the latest available differential data. (auth)

24834 REACTIONS OF NUCLEI WITH PIONS AT THE 3-3 RESONANCE. Chivers, D. T.; Domingo, J. J.; Rimmer, E. M.; Witcomb, R. C.; Allardyce, B. W.; Tanner, N. W. (Oxford Univ.). Phys. Lett., 26B: 573-5(Apr. 1, 1968).

Activation cross sections of reactions of pions with light nuclei were measured over the energy range 80 to 280 MeV. Most of the reactions appear to be of single-particle character, but quasifree scattering does not show the expected ratio of 3 for π^-/π^+. (auth)

Nuclear Properties and Reactions, $20 \leq A \leq 89$

Refer also to abstracts 23008, 23593, 24516, 24548, 24788, 24854, 24862, 24880, 24881, 24888, 24900, 24901, 24911, 24912, and 24914.

24835 (BARC-305) PROGRESS REPORT ON NUCLEAR DATA ACTIVITIES IN INDIA: IV. (Bhabha Atomic Research Centre, Bombay (India)). 1967. 42p. Dep.

A number of investigations of nuclear decay schemes, level schemes, models, and reactions are summarized together with neutron diffraction studies of crystal and magnetic structure. The development of a transistorized current integrator for nuclear reaction studies is also reported, and studies of thermal neutron wave propagation in graphite and neutron pulse propagation in graphite are summarized. (D.C.W.)

24836 (JINR-P1-3721) IZMERENIE VEROYATNOSTI ISPUSKANIYA TYAZHELYKH ZARYAZHENNYKH CHASTITS PRI ZAKHVATE μ MEZONOV YADRAMI NEONA. (Measurement of the Probability of Heavy Charged Particle Emission in Negative Muon Capture by Neon Nuclei). Komarov, V. I.; Savchenko, O. V. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1968. 8p. (In Russian). Dep.

The probability W of heavy charged particle emission per event of nuclear muon capture in neon was measured by the isotropic discharge chamber method. The value $W = 0.20 \pm 0.04$ obtained by the detection of particles having a range larger than 4.2 mg cm^{-2} Ne points out the essential contribution of 1- to 5-MeV protons to the energy spectrum of emitted particles. (auth)

24837 (KR-123) CROSS-SECTIONS OF SOME (n,p) AND (n,α) REACTIONS INDUCED BY REACTOR FAST NEUTRONS.

Steinnes, E. (Institutt for Atomenergi, Kjeller (Norway)). Dec. 1967. 15p. Dep.

Some (n,p) and (n,α) reactions induced by reactor fast neutrons in elements of medium and high atomic number were studied by means of radiochemical separation methods. The previously unreported cross sections of the reactions $^{81}Br(n,p)^{81m}Se$, $^{81}Br(n,p)^{81}Se$ and $^{106}Cd(n,p)^{106}Ag$ were found to be $(2.0 \pm 0.4) \cdot 10^{-2}$mb, $(1.2 \pm 0.3) \cdot 10^{-2}$mb, and 2.7 ± 0.2 mb, respectively. For the reaction $^{133}Cs(n,\alpha)^{130}I$, the present result $(2.7 \pm 0.6) \cdot 10^{-3}$mb is significantly higher than previously published values. As the monitoring reaction, $^{27}Al(n,\alpha)^{24}Na$ was used. (auth)

24838 ASYMMETRY OF ANGULAR DISTRIBUTION OF THE PRODUCTS OF THE REACTIONS $^{60}Ni(d,d)^{60}Ni$ WITH POLARIZED DEUTERONS. Klimenko, A. S.; Malko, A. I.; Saltykov, L. S.; Chirko, V. I. (Inst. of Physics, Kiev). Ukr. Fiz. Zh., 12: 2076-8(Dec. 1967). (In Russian).

The asymmetry of the angular distribution of scattered polarized deuterons was measured for a ^{60}Ni target. Polarized deuterons were obtained by scattering 13.8-MeV deuterons on a carbon target, those emerging at a scattering angle of 30° (laboratory) with an energy of 11.8 ± 0.2 MeV were then further scattered from a 95.4% enriched 16 mg/cm^2 ^{60}Ni target. The B/A and C/A asymmetries were measured for laboratory angles (second scattering) of 18, 24, 30, 36, and 42°. The quantities B/A and C/A are defined as $2(L-R)/[L + R + 2 (UD)^{1/2}]$ and $[L + R - 2 (UD)^{1/2}]/[L + R + 2 (UD)^{1/2}]$, respectively. In the two expressions L, R, U, and D are the number of events registered in detectors placed left, right, up, and down with respect to the reaction plane. (TTT)

24839 INVESTIGATION OF THE MECHANISM OF THE REACTION $^{27}Al(\alpha,p)^{30}Si$ IN THE 10 TO 25 MeV α-PARTICLE ENERGY REGION. Spasskii, A. V.; Teplov, I. B.; Fateeva, L. N. (Inst. of Nuclear Physics, Moscow). Yadern. Fiz., 7: 251-60 (Feb. 1968). (In Russian).

The reaction $^{27}Al(\alpha,p)^{30}Si$ was studied in the 10 to 25 MeV α-particle energy region. For three groups of protons corresponding to the formation of the ground, first, and the next three excited states of the nucleus ^{30}Si, angular distributions at six values of the energy of incident particles and the excitation functions at 30, 90, and 160° were measured. The results obtained are discussed on the basis of the theory of direct processes and of the mechanism of compound-nucleus formation. In the 8 to 25 MeV energy region the dependences of the total cross sections of the reactions $^{27}Al(\alpha,n)^{30}P$ and $^{27}Al(\alpha,2p)^{29}Al$ on the energy were measured. (auth)

24840 PARAMETERS OF THE NUCLEAR OPTICAL MODEL FROM THE DATA ON 1.5-MeV NEUTRON ELASTIC SCATTERING. Korzh, I. A.; Kashuba, I. E.; Kozin, B. D.; Pasechnik, M. V. (Inst. of Physics, Kiev). Yadern. Fiz., 7: 277-82(Feb. 1968). (In Russian).

The results of the analysis, by means of the six-parameter optical model, of the experimental data on the total and differential cross sections of neutrons with the initial energy 1.5 MeV on the nuclei Na, Al, P, Ti, Cr, Fe, Co, Ni, Cu, Zn, Zr, Nb, Mo, Ag, In, Sn, Sb, I, Sm, Yb, Ta, W, ^{184}W, Pt, Au, Hg, Tl, Pb, Bi, Th, ^{235}U, and ^{238}U are presented. Optimal parameters of the model V, W and a were determined. It is shown that for deformed nuclei, one can not obtain theoretical agreement with the experimental data by fitting the parameters of the spherical model potential. (auth)

24841 ELASTIC SCATTERING OF PROTONS BY PHOSPHORUS AND THE REACTIONS $^{31}P(p,\alpha_0)^{28}Si$ AND $^{31}P(p,\alpha_1)^{28}Si$ IN THE 1.0 TO 3.8-MeV ENERGY REGION. Karadzhev, K. V.; Man'ko, V. I.; Chukreev, F. E. Yadern. Fiz., 7: 242-50(Feb. 1968). (In Russian).

Elastic scattering of protons by phosphorus as well as the reactions $^{31}P(p,\alpha_0)^{28}Si$ and $^{31}P(p,\alpha_1)^{28}Si$ were investigated in the proton energy region 1.0 to 3.8 MeV. The energy dependence of the scattering differential cross section and of the reaction under the angles 150 and 90°, respectively, in the lab system was obtained. The presence of numerous and strong resonances in the elastic scattering of protons by phosphorus indicates that for the levels of the nucleus ^{32}S the partial proton and α-particle widths are approximately of the same order of magnitude. In the maxima of the most resonances of the reactions mentioned, α-particle angular distributions were measured (in all, ~40 distributions) and expanded over Legendre polynomials using the method of least squares. A considerable part of distributions contains polynomials not higher than of the second order of magnitude. It means that the spin of corresponding states is not more than one. (auth)

24842 SOME NEUTRON REACTION CROSS SECTIONS FOR ^{111}Cd, ^{112}Cd, ^{87}Sr, AND ^{58}Ni. Temperley, J. K. (Army Nuclear Defense Lab., Edgewood Arsenal, Md.). Nucl. Sci. Eng., 32: 195-200(1968).

The cross sections for the reactions $^{111}Cd(n,n')^{111m}Cd$, $^{112}Cd(n,2n)^{111m}Cd$, $^{87}Sr(n,n')^{87m}Sr$, $^{58}Ni(n,p)^{58m+g}Co$, $^{58}Ni(n,2n)^{57}Ni$, and $^{58}Ni[(n,d) + (n,np) + (n,pn)]^{57}Co$ were measured by the activation method. Measurements were performed in the energy regions from 2.2 to 3.5 MeV and from 13.7 to 14.8 MeV. The cross sections obtained for the ^{111}Cd and ^{87}Sr reactions indicate that both these isotopes should prove useful as neutron flux monitors. The cross sections obtained for the ^{58}Ni reactions are in good agreement with the results of recent investigations. (auth)

24843 EVIDENCE FOR A DIRECT-CAPTURE MECHANISM IN THE REACTION $^{55}Mn(n,\gamma)^{56}Mn$. Comfort, J. R. (Yale Univ., New Haven). Contract AT(30-1)-3223. Phys. Rev. Lett., 20: 941-4(Apr. 22, 1968).

Transition strengths for the reaction $^{55}Mn(d,p)^{56}Mn$ were measured and were compared with corresponding data for the reaction $^{55}Mn(n,\gamma)^{56}Mn$ using a simple model of reaction mechanisms. The results are consistent with the interpretation of the thermal neutron capture in terms of a dominant direct component. (D.C.W.)

24844 PROTON POLARIZATION BY INELASTIC SCATTERING ON NICKEL ISOTOPES. Halil, Munib Adel; Romanovskii, E. A.; Timushev, G. F. Vestn. Mosk. Univ., Ser. III. Fiz. Astron., No. 2, 98-100(Mar.-Apr. 1967). (In Russian).

An estimate of the magnitude of polarization during inelastic scattering of protons having energies of 6 to 6.5 MeV on ^{58}Ni, ^{60}Ni, and ^{62}Ni isotopes having a thickness of 3 to 4 mg/cm^2 with excitation of the first levels of these nuclei was carried out at scattering angles $\theta > 75°$ for the following reasons: first, at $\theta > 75°$ the contribution of direct processes to the inelastic scattering cross-section can be neglected and secondly, at large scattering angles the proton inelastic scattering cross-section is 15 to 20% of the elastic scattering cross-section so that a difference method can be used to estimate the polarization during inelastic scattering. The elastic and inelastic protons were scattered a second time by a polystyrene film, and were caught in a nuclear emulsion. The polarizations of the inelastically scattered protons were calculated and presented as a function of the incident proton energy and mass number of the isotope. These results must be considered as preliminary, since the experimental error was large. (TTT)

24845 HALF-LIVES OF RADIONUCLIDES. III. Reynolds, S. A.; Emery, J. F.; Wyatt, E. I. (Oak Ridge National Lab., Tenn.). Nucl. Sci. Eng., 32: 46-8(Apr. 1968). (ORNL-P-3471).

Half-lives of 36 radionuclides were newly determined, or old data were reevaluated. In general, the activity of a purified sample was followed for two or more half-lives. The data were analyzed by least squares, using a modern computer program. (auth)

24846 MICROSCOPIC CALCULATION OF THE ^{89}Y ANALOG-STATE ESCAPE AND DAMPING WIDTHS. Beres, William P.; Divadeenam, M. (Duke Univ., Durham, N. C.). Phys. Rev. Lett., 20: 938-41(Apr. 22, 1968).

The escape and damping widths for the $1/2^+$, $3/2^+$, and $5/2^+$ ^{89}Y analog states in proton elastic scattering by ^{88}Sr at 5, 6, and 7 MeV were calculated assuming that the ^{88}Sr target is in its ground state. (D.C.W.)

24847 POTENTIAL SCATTERING BY A NUCLEAR HARTREE–FOCK FIELD. Vautherin, D.; Veneroni, M. (Institut de Physique Nucleaire, Orsay, France). Phys. Lett., 26B: 552-5(Apr. 1, 1968).

The Hartree-Fock spectra of ^{16}O and ^{40}Ca nuclei are computed in coordinate space. In lowest order, the continuum states correspond to neutron elastic scattering. Phase shifts are given, and single-particle resonances are discussed. (auth)

24848 DOPPLER SHIFT ATTENUATION METHOD DETERMINATIONS OF NUCLEAR LEVEL LIFETIMES IN ^{14}N, ^{19}F, ^{23}Na, ^{24}Mg, ^{26}Mg, ^{27}Al, AND ^{28}Si. Robinson, Stephen Walter. Bloomington, Ind., Indiana Univ., 1967. 123p.

Thesis.

The lifetimes of a number of nuclear excited states were determined by a variation of the Doppler shift attenuation method. The experimental efforts were primarily directed at levels of ^{24}Mg, ^{26}Mg, and ^{28}Si, while ^{14}N, ^{19}F, ^{23}Na, and ^{27}Al were studied in less detail. The excited states were produced by inelastic scattering of 22-MeV alpha particles from the Indiana University cyclotron. Gamma-ray spectra were collected at forward and backward angles to the beam direction in coincidence with pulses from alpha particles striking an annular solid-state detector which subtended the extreme backward angles. Doppler shifts were observed in these gamma-ray spectra due to the forward motion of the recoil nuclei. The targets used in the work had thick backings of gold or magnesium in which the recoil nuclei were stopped.

The observed Doppler shifts therefore depended upon the lifetimes of the excited states involved and the times required for the recoil nuclei to stop in the backing material. For cases in which the observed shifts were less than the maximum possible shifts calculated from the kinematics of the reaction, it was possible to calculate the nuclear lifetimes from the measured attenuations of the Doppler shifts and the stopping power of the backing material. The measurements that were performed included the first seven excited states of ^{24}Mg, the first two excited states and probably two members of the triplet at 4.35 MeV in ^{26}Mg, the first three excited states and one member of the 6.88-MeV doublet in ^{28}Si, the second excited state of ^{14}N, and the 2.79-MeV state of ^{19}F. In addition, limits were obtained for the lifetimes of several levels in ^{23}Na, and ^{27}Al. The lifetimes measured were the order of 10^{-13} second. The results for the three even-even nuclei were compared with the predictions of several collective models of nuclear structure. These included the rotational model, the vibrational model, the Davydow-Filippov asymmetric rotator model, and the rotation-vibration interaction calculations of Faessler et al. In each of the three even-even nuclei the transitions between members of the ground state rotational band are in agreement with the theories. However, the transitions between rotational bands are only in qualitative agreement with the model predictions for ^{24}Mg, and the agreement between experiment and theory becomes worse for the heavier nuclei. It is also difficult to reproduce the energy level positions in ^{26}Mg and ^{28}Si with the models considered. It is concluded that the low-lying levels of ^{26}Mg and ^{28}Si are not easily interpretable in terms of simple types of collective motion. There are no detailed shell model calculations available which predict the properties of the levels of these nuclei. There is possible evidence for a shell model effect exhibited by the M1 transitions in ^{24}Mg and ^{26}Mg. The reduced transition rate between T = 0 levels in ^{24}Mg is 20,000 times smaller than the rate between T = 1 levels in ^{24}Mg. The upper limit set upon the lifetime of the 2.79-MeV state in ^{19}F shows a large enhancement if the decay is E2, as recent work indicates. (Disser. Abstr.)

24849 (p,α) REACTIONS IN LIGHT NUCLEI AT 40 MeV. Shkolnik, Vladimir. Minneapolis, Univ. of Minnesota, 1967. 178p.

Thesis.

In order to study the usefulness of the (p,α) reaction as a tool in nuclear spectroscopy, a limited survey was made of this reaction involving light nuclei, and at incident proton energy of 40 MeV. This energy was considered high enough to ensure that the major contribution comes from direct processes and is not associated with the compound nucleus. Targets containing ^{12}C, ^{14}N, ^{16}O, ^{19}F, ^{20}Ne, ^{24}Mg, and ^{27}Al were exposed to the proton beam from the University of Minnesota Linear Accelerator; the reaction products were momentum-analyzed by the 40 inch magnetic spectrometer, and detected in its focal plane by the 32-detector solid-state array. Alpha particles were identified by their specific energy loss, and their spectra plotted. Angular distributions and/or absolute differential cross sections were measured for angles between 10 and 60° in the laboratory system. The upper limit in the angular range was determined by the beam intensity, which also set the overall resolution limit for the analyzing system at about 400 keV, i.e., states closer than that in excitation could not be separated. Approximate selection rules for direct (p,α) processes were derived; it was shown that these rules are exact if the three nucleons are picked up while in a relative S-state (and remain so in the alpha particle). In nine out of twelve observed transitions to single excited states, it was possible to correlate the shape of each angular distribution with the L value predicted by the selection rules for the orbital angular momentum and parity. The L values involved were 0, 1, and 2; the lack of transitions to resolved states requiring unique values $L \geq 3$ set the limit on the number of identified L values. In three transitions with $J_i - J_f = (\frac{1}{2})^-$ the shape of the angular distribution suggested strongly the parity-forbidden L = 0 (but still allowed by the angular momentum) instead of an L = 1 allowed by both selection rules. No such violation was observed for the angular momentum selection rule. The same twelve angular distributions were successfully fitted with predictions of the diffraction model of Henley and Yu, assuming pickup of three nucleons. The radii used varied from 2.0 fermis for the ^{12}C target, to 3.1 fermis for ^{27}Al. Diffraction model fits were then used to estimate relative contributions from unresolved states, by using L values allowed by both selection rules and assuming only in some cases with $J_i - J_f = (\frac{1}{2})^-$ violation of parity. Results obtained from (p,α) reactions at 40 MeV were compared with those of other authors obtained at different proton energies, and some of their angular distributions fitted with the diffraction model. No other numerical calculations of parameters relevant for nuclear structure are presented. (Disser. Abstr.)

24850 RADIATIVE ALPHA CAPTURE BY ^{38}Ar AND ^{36}Ar. Nahm, Chun Woo. University Park, Pa., Pennsylvania State Univ., 1967. 69p.

Thesis.

The radiative capture reactions ^{38}Ar(α,γ)^{42}Ca and ^{36}Ar(α,γ)^{40}Ca was studied in the region E_α = 3 to 6 MeV. Embedded targets, which were produced directly in an isotope separator by driving the argon ions into the metallic backings, were used for both reactions. The yield functions were measured at an angle of θ = 45° from the beam with the face of the detector adjacent to the target. The yield curve for the ^{38}Ar(α,γ)^{42}Ca reaction showed a great deal of complicated structure. At least 59 resonances were observed in this reaction, and angular distributions were measured for more than 40 of the stronger resonances. These distributions showed that 23 of the resonance states are 1⁻. The remaining strong resonances did not appear to yield ground state transitions. An attempt was made to establish an absolute scale for the strengths of the ^{38}Ar(α,γ)^{42}Ca resonances by means of a comparison with a known strength of the ^{24}Mg(α,γ)^{28}Si resonance at E_α = 3.200 MeV and published saturation value for 45 keV Ar ions in tantalum. The partial radiation width Γ_{γ_0} for the largest of E1 transitions was then obtained as 1.27 eV, a reasonable value for nuclei of this mass. The number of 1⁻ levels observed was compared with theory and was shown to be an order of magnitude less than expected on the basis of a level density theory. Probably, this fact may reflect a systematic bias in radiative capture experiments towards the detection of only the strongest transitions. The resonance energies E_α in the ^{38}Ar(α,γ)^{42}Ca reaction, the corresponding ^{42}Ca excitation energies E_x, spins and parities J^π, the strengths $(2J+1)\,\Gamma_\alpha\Gamma_\gamma/\Gamma$, the lower limits of Γ_γ, and the remarks are presented in a table. In contrast, only one capture resonance appears to be found which can be attributed to the ^{36}Ar(α,γ)^{40}Ca reaction. This finding was based on a report of the ^{39}K(p,γ$_0$)^{40}Ca and the ^{39}K(p,α$_0$)^{36}Ar reactions which indicates the possibility of five corresponding ^{36}Ar(α,γ$_0$)^{40}Ca resonances in the region studied. A special search was made for the strongest of these resonances to be expected at E_α = 5.32 MeV. The results showed that the yields were too small to permit an angular distribution measurement. An explanation of the difference in the results obtained from ^{38}Ar and ^{36}Ar targets was attempted, and the difference could be understood at least in part. Finally, dipole transitions between the states of isobaric spin T = 0 in self-conjugate nuclei are inhibited by at least an order of magnitude. Secondly, the (α,γ) reaction on ^{36}Ar has large competition from the (α,p) reaction, whereas the (α,p) competition on ^{38}Ar virtually does not exist. Lastly, the level density of ^{40}Ca, even at the high excitations encountered here, is expected to be distinctly lower than that of neighboring nuclei due to its doubly closed shell structure. (Disser. Abstr.)

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Refer also to abstracts 23045, 23310, 23315, 23907, 24787, 24788, 24835, 24837, 24840, 24842, 24845, 24900, 24901, 24904, 24911, and 24912.

24851 (AECL-3043) THE NEUTRON INELASTIC CROSS SECTION FOR THE PRODUCTION OF ^{103m}Rh. Butler, J. P.; Santry, D. C. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). Mar. 1968. 9p. (CONF-680307-28). Dep. CFSTI. CAN $0.50.

From 2nd Conference on Neutron Cross Sections and Technology, Washington, D. C.

The cross section for the threshold reaction ^{103}Rh(n,n′)^{103m}Rh was measured by the activation method from 0.18 to 14.8 MeV. Neutrons with an energy spread varying from ±30 to ±80 keV were obtained from the T(p,n)^{3}He, D(d,n)^{3}He and T(d,n)^{4}He reactions using an EN tandem Van de Graaff accelerator and a 2-MeV accelerator. For energies below 5.5 MeV, the neutron flux was determined with a calibrated neutron long counter while at higher energies the measurements were made relative to the known cross section for ^{32}S(n,p)^{32}P reaction. The cross section for ^{103}Rh(n,n′)^{103m}Rh increases rapidly with energy from a value of 25 ± 3 mb at 0.18 MeV to a maximum of 1385 ± 55 mb near 6 MeV. The excitation curve shows distinct discontinuities in slope at about 300, 550 and 800 keV. The decrease in slope at 300 and 800 keV is attributed to the appearance of levels of negative parity which prefer to decay to the ground state, while the increase at 550 keV is caused by levels which decay to the isomeric state. From the excitation curve an effective cross section of 716 ± 40 mb was calculated for a fission-neutron spectrum. (auth)

24852 (BNL-12353) THERMAL NEUTRON CROSS SECTIONS AND RESONANCE INTEGRALS FOR TRANSURANIUM ISOTOPES. Prince, A. (Brookhaven National Lab., Upton, N. Y.). [1967]. 18p. (CONF-680307-29). Dep. CFSTI.

From 2nd Conference on Neutron Cross Sections and Technology, Washington, D. C.

A systematic procedure for estimating fission and capture thermal cross sections and fission and capture resonance integrals for transuranium isotopes is outlined. The method involves establishing a correlation between the difference of the binding energy and fission threshold ($B_n - E_f$) and the cross sections and resonance integrals. Estimated values for σ_f, σ_γ, I_f, I_γ, (ν_p), α, η, and (E_k) (average kinetic energy of fission products) for more than 280 isotopes ranging from $_{88}Ra^{212}$ to $_{108}X^{284}$ have been completed. The method of analysis and recommendations are given for possible study and improvements. (auth)

24853 (GA-8557) CROSS SECTION MEASUREMENTS OF ZIRCONIUM. Lopez, W. M. (Gulf General Atomic, Inc., San Diego, Calif.). Feb. 28, 1968. Contract AT(04-3)-167. 12p. (CONF-680307-31). Dep. CFSTI.

From 2nd Conference on Neutron Cross Sections and Technology, Washington, D. C.

Time-of-flight capture, self-indication, and transmission measurements of natural zirconium samples and samples enriched in ^{91}Zr (91%) were made at the Gulf General Atomic linear accelerator facility. Parameters were obtained for resonances in ^{91}Zr in the neutron energy range below 4 keV. The radiation width, $\Gamma_\gamma = 0.12 \pm 0.03$ eV, obtained in this work for the 292- and 681-eV resonances is considerably smaller than previously reported values obtained from transmission measurements. The value of Γ_γ is, however, consistent with previous values deduced from low-resolution capture measurements. Low-energy (0.01 to 1 eV) capture cross sections for natural zirconium and a table of resonance parameters for ^{91}Zr are presented. (auth)

24854 (IA-1128, pp 12-20) NUCLEAR PHYSICS. (Israel Atomic Energy Commission, Tel Aviv).

Some investigations of the resonance scattering of neutron-capture gamma rays, the Moessbauer effect using capture gamma rays, and gamma resonance fluorescence using gaseous sources are summarized. A facility for studying capture gamma-ray resonance scattering is briefly described, and an interpretation of the nonlinear effects of beam-plasma instability in partially ionized gases is outlined. An investigation of alpha-particle emission in thermal neutron fission of ^{236}U is also summarized. (D.C.W.)

24855 (IN-1157(Rev.)) BURNUP DETERMINATION OF NUCLEAR FUELS. Project Report for the Quarter, January 1-March 31, 1967. Lisman, Frederick L.; Maeck, William J.; Rein, James E. (eds.) (Idaho Nuclear Corp., Idaho Falls). Jan. 1968. Contract AT(10-1)-1230. 53p. Dep. CFSTI.

REACTOR FUELS — burnup determination in, methods development for

URANIUM U-233, U-235 — neutron fission of, absolute yields of stable isotopes from thermal, (E)

RUBIDIUM Rb-85, Rb-87, STRONTIUM Sr-88, Sr-90, BARIUM Ba-138 — yields in thermal fission of uranium-233 and -235, absolute, (E)

FISSION PRODUCTS — determination of stable, methods for isotope dilution mass spectrometric (D.L.C.)

24856 (JINR-P6-3695) UROVNI ^{156}Gd, VOZBUZHDAYUSHCHIESYA PRI RASPADE ^{156}Tb. (The ^{156}Gd Levels Excited by the Decay of ^{156}Tb). Galan, P.; Kuznetsov, V. V.; Kuznetsova, M. Ya.; Nielsen, O. B.; Urbanec, J.; Finger, M.; Khristov, D.; Jursik, I. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1968. 106p. (In Russian). Dep.

The conversion electron spectra, γ-ray spectra, and $e-\gamma$ and $\gamma-\gamma$ coincidence spectra from the decay of ^{156}Tb were investigated. The decay scheme, $^{156}Tb \rightarrow {}^{156}Gd$ is suggested. The $e-\gamma$ and $\gamma-\gamma$ coincidence experiments prove the existence of the 60.0, 86.5, 105.3, 118.0, 235.2, 266.6, 268.8, 286.8, 326.0, 367.7, 427.4, 451.3, 488.8, and 647.8 keV levels in the ^{156}Gd nucleus. The scheme of the ^{156}Gd levels is considered from the point of view of generalized and superfluid models. The levels with the energies 592.6 keV ($5/2^-$) and 647.8 keV ($5/2^-$) are considered to be the states of the rotational band of β-vibrational state [521] $\downarrow \beta$, while the levels with the energies 559.9 keV ($1/2^-$) and 615.5 keV ($3/2^-$) are considered to be the terms of the rotational band of mixed stage [521] $\downarrow$ with the γ-vibrational state [521] $\downarrow (\gamma K = K_0 - 2)$. (auth)

24857 (JINR-P7-3732) MASSOVOE RASPREDELENIE OSKOLKOV DELENIYA YADER VISMUTA I URANA TYAZHELYMI IONAMI. (Mass Distribution of the Fission Fragments of the Bismuth and Uranium Nuclei by Heavy Ions). Karamyan, S. A.; Normuratov, F.; Oganesyan, Yu. Ts.; Penionzhkevich, Yu. E.; Pustyl'nik, B. I.; Flerov, G. N. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1968. 14p. (In Russian). Dep.

Mass distributions of the fission fragments were measured in the reactions $^{238}U(^{20}Ne,f)$, $^{238}U(^{40}Ar,f)$, and $^{209}Bi(^{20}Ne,f)$. The isotopes produced in these reactions were identified by the γ-spectroscopic method using a Ge(Li) γ spectrometer. It is shown that the mass distribution widens with the increase of the excitation energy and the Z^2/A of the fissioning nucleus. The width parameter σ^2 of the mass distribution increases more sharply with the increase of the excitation energy than by $\sigma^2 \approx T$. The constant C of charge distribution also increases but more weakly than σ^2. (auth)

24858 (KR-124) COMPARISON OF ρ_{28} MEASURED BY THE COINCIDENCE METHOD AND BY THE CHEMICAL SEPARATION METHOD. Skaali, Toralf B. (Institutt for Atomenergi, Kjeller (Norway)). Dec. 1967. 44p. Dep.

Two different methods for determination of relative neptunium activity in irradiated uranium foils were investigated: a chemical separation technique for isolation of ^{239}Np and a coincidence method in which the fission product and natural background activities are suppressed relative to the neptunium counting rate. The methods were compared by measuring ρ_{28}, the ratio of epicadmium to subcadmium neutron capture in ^{238}U, for two different core configurations in the zero-power critical facility NORA. A detailed description of the separation procedure and counting technique is given together with values of ρ_{28} obtained for the lattices investigated. The two methods give results which agree within the experimental errors. (auth)

24859 (LA-DC-9403) MEASUREMENT OF ABSOLUTE DELAYED NEUTRON YIELDS FROM 14 MeV FISSION. Masters, C. F.; Thorpe, M. M.; Smith, D. B. (Los Alamos Scientific Lab., N. Mex.). [1965]. Contract W-7405-eng-36. 4p. (CONF-680601-10). CFSTI.

From 14th Annual Meeting of the American Nuclear Society, Toronto, Ontario.

A series of yield measurements was carried out on ^{232}Th, ^{235}U, and ^{238}U at incident neutron energies of 3 and 14 MeV using a modulated-source technique. An appreciable decrease in the yield at 14 MeV with respect to the yield at 3 MeV was observed. This decrease is in accord with theoretical predictions based on the behavior of fission mass and charge distributions and the known decrease in fission chain lengths with increasing energy of the neutron inducing fission. (D.C.W.)

24860 (TID-3317) TRANSPLUTONIUM ELEMENTS. A BIBLIOGRAPHY. PART I. $95 \leq Z \leq 101$. PART II. $Z \geq 102$. (Division of Technical Information Extension (AEC), Oak Ridge, Tenn.). Feb. 1968. 57p. Dep. CFSTI.

A bibliography on transplutonium elements is presented in two parts. Part I comprises 345 references on the production and physical and nuclear properties of transplutonium elements in the atomic-number range $95 \leq Z \leq 101$. Part II comprises 234 references on all aspects of transmedelevium elements ($Z \geq 102$). (B.G.D.)

24861 (WANL-TME-1721) A SINGLE LEVEL ANALYSIS OF ^{233}U NEUTRON CROSS SECTIONS; AN $n + {}^{233}U$ MULTIGROUP CROSS SECTION LIBRARY. Schneider, M. J. (Westinghouse Electric Corp., Pittsburgh, Pa. Astronuclear Lab.). Dec. 1967. Subcontract NP-1. 107p. Dep. CFSTI.

Total, capture, and fission cross sections for $n + {}^{233}U$ were simultaneously least squares fit over the energy range 0.4 to 61.4 eV using the single-level Breit-Wigner formula. Sixty-three resonances were found in this range. Good agreement was obtained between integral data and this fit to differential data for the resonance integrals of ^{233}U. Resonance parameters are given, along with brief statistical analyses of them. A multigroup cross-section library from .001 eV to 10 MeV is presented. (auth)

24862 (WANL-TME-1746) CHANGES IN GAM AND TNS CROSS SECTION LIBRARIES: NEW ACTIVATION CROSS SECTIONS. Schneider, M. J. (Westinghouse Electric Corp., Pittsburgh, Pa. Astronuclear Lab.). Jan. 1968. Subcontract NP-1. 47p. Dep. CFSTI.

Some recent experimental data and evaluations of activation cross sections for several nuclei are analyzed; and new GAM, TNS, and B1T libraries based on these analyses are presented. The cross sections for the isotopes ^{55}Mn, ^{115}In, and ^{32}S, and for natural Pb and Zr are analyzed. A preliminary analysis of the $^{93}Nb(n,\gamma)$ cross section is also summarized. (D.C.W.)

24863 (BNL-tr-197) TOTAL AND FISSION CROSS SECTIONS OF ^{239}Pu. Derrien, H.; Blons, J.; Eggermann, C.; Michaudon, A.; Paya, D.; Ribon, P. Translated for Brookhaven National

Lab., Upton, N. Y., from pp 195-210 of STI/PUB-140(Vol.2) presented at IAEA Conference on Nuclear Data Reactors, Paris, October 17-21, 1966. 22p. Dep. CFSTI. JCL $2.60 fs, $1.10 mf.

The neutron fission and total cross sections of ^{239}Pu were measured, and the resonances were identified up to 442 eV. Resonance parameters were obtained by shape analysis using a method of least squares in which the theoretical function is a sum of Breit-Wigner formulas for a level that is broadened by the Doppler effect. A complete set of resonance parameters was obtained up to 250 eV; beyond 250 eV only values of Γ and $2g\Gamma$ could be obtained. (D.C.W.)

24864 ISOTOPIC DISTRIBUTION OF SODIUM FRAGMENTS EMITTED IN HIGH-ENERGY NUCLEAR REACTIONS. IDENTIFICATION OF ^{27}Na AND POSSIBLE EXISTENCE OF HEAVIER Na ISOTOPES. Klapisch, R.; Philippe, C.; Suchorzewska, J.; Detraz, C.; Bernas, R. (Institut de Physique Nucleaire, Orsay, France. Centre de Spectrometrie Nucleaire, Orsay, France. Spectrometrie de Masse, Orsay, France). Phys. Rev. Lett., 20: 740-2(Apr. 1, 1968).

The yields of Na isotopes from proton reactions with Ir, ^{100}Mo, Ta, and U at 10.5 GeV were measured. Nuclear recoils were stopped in heated graphite from which they quickly diffused. By surface ionization on a Re surface at about 1500°C, Na was selectively ionized. Mass analysis of Na ions was then performed by a Nier-type arrangement (60° magnetic sector, 15-cm radius). Relative production cross sections for the Na isotopes were determined, and peaks at masses 27, 28, and 29 were observed. However, the masses 28 and 29 could not be uniquely attributed to Na isotopes. (D.C.W.)

24865 PROPERTIES OF THE ISOTOPE ^{256}102. Flerov, G. N.; Demin, A. G.; Druin, V. A.; Lobanov, Yu. V.; Mikheev, V. L.; Polikanov, S. M.; Shchegolev, V. A. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 7: 239-41(Feb. 1968). (In Russian).

The isotope ^{256}102 was synthesized in the reactions ^{242}Pu(^{18}O,4n) and ^{238}U(^{22}Ne,4n). In accordance with the previous measurements for the α-particle energy of the isotope ^{256}102 the value 8.43 ± 0.03 MeV was obtained. The value of the decay half-life, for which $T_{\frac{1}{2}} = 3.7 \pm 0.5$ sec was obtained, was specified. A conclusion is made that the value ~1500 sec, previously established for the partial period of the ^{258}102 spontaneous fission, is only the lower limit of this value. (auth)

24866 SPIN-ORBITAL SPLITTING AND SPIN-WAVE RESONANCE IN HEAVY NUCLEI. Moskovkin, V. M.; Yudin, N. P.; Shitikova, K. V. (Inst. of Nuclear Physics, Moscow). Yadern. Fiz., 7: 320-3(Feb. 1968). (In Russian).

Some singularities of the spin-wave resonance in the intermediate and heavy nuclei are considered. It is shown that the spin-orbit interaction does not prevent the formation of collective spin-wave states and is essential when finding the energy of the spin-wave resonance. (auth)

24867 MEASUREMENTS OF HALF-LIVES IN ^{176}Ta. Abou-Leila, Hussein; Ader, Bertrand; Vanhorenbeeck, Jean (Institut de Physique Nucleaire, Orsay, France). Compt. Rend., Ser. A and B, 266: 96-9(Jan. 8, 1968). (In French).

A time-amplitude converter was used to measure the half-life of the 100.2-keV E1 transition to be $2.5 \pm 3 \times 10^{-9}$ sec and to measure two other half-lives. The results are discussed. (tr-auth)

24868 NEUTRON RESONANCES OF THE ERBIUM ISOTOPES. Karzhavina, E. N.; Popov, A. B.; Yazvitskii, Yu. S. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 7: 225-38 (Feb. 1968). (In Russian).

Transmission and yield of the γ rays from the neutron capture were measured for natural erbium samples as well as for samples enriched by the isotopes ^{164,166,167,168,170}Er. The measurements were made using a neutron spectrometer with a resolution from 80 to 6 nsec/m. As a result, the isotope identification was carried out, and the parameters of the neutron resonances were determined for ^{164}Er and ^{167}Er in the energy region up to 300 eV, for ^{166}Er up to 1500 eV, and for ^{168}Er and ^{170}Er up to 4000 eV. For the isotopes considered, the values of the mean distance between the levels D, the strength function S_0, and the radiation width Γ_γ are obtained. (auth)

24869 FRACTIONAL YIELDS OF DELAYED NEUTRON GROUPS FOLLOWING THE FISSION OF ^{238}U BY 18 TO 21 MeV NEUTRONS. Maksyutenko, B. P.; Ramazanov, R.; Tarasko, M. Z. Yadern. Fiz., 7: 274-6(Feb. 1968). (In Russian).

Fractional yields of delayed neutrons from ^{238}U following its fission by neutrons with the energies 18.2, 18.5, 18.8, 19.3, 19.7, 20.5, and 21.00 MeV were measured. In the step of the fission cross section there is some structure in fractional yields of the neutron groups. (auth)

24870 NEUTRON FISSION CROSS SECTIONS OF ^{226}Ra AND ANGULAR DISTRIBUTIONS OF FRAGMENTS. Babenko, Yu. A.; Nemilov, Yu. A.; Selitskii, Yu. A.; Funshtein, V. B. Yadern. Fiz., 7: 269-73(Feb. 1968). (In Russian).

Measurements of the cross section of ^{226}Ra fission induced by neutrons with energies from 3 up to 15 MeV show that its energy dependence is not monotonous. The fission barriers of ^{227}Ra and ^{226}Ra are found to be 8.5 ± 0.5 MeV. The measured anisotropy of the separation of fragments confirms the presence of the emissive fission at $E_n > 9$ MeV. The shape of the angular distribution of fragments from the fission of Ra by neutrons with energy 14.4 to 14.8 MeV indicates the high yield of fragments at the angle of about 60° to the direction of the neutron beam. (auth)

24871 EXCITATION FUNCTION OF THE REACTIONS INDUCED ON TERBIUM BY 26.9-MeV DEUTERONS. Tran Minh, Duc; Tousset, Jean (Univ. de Lyon, Villeurbanne, France). Compt. Rend., Ser. A and B, 266: 100-2(Jan. 8, 1968). (In French).

A radiochemical method was used to measure the cross sections of the reactions ^{159}Tb(d,2n)^{159}Dy, ^{159}Tb(d,4n)^{157}Dy, and ^{159}Tb(d,p)^{160}Tb for deuterons with energies between 6 and 26.9 MeV. (tr-auth)

24872 ISOMERIC (n,2n) CROSS-SECTION RATIOS AND SPIN CUT-OFF PARAMETER CALCULATIONS. Curzio, G. (Univ., Pisa, Italy); Sona, P. Nuovo Cim., 54B: 319-25(Apr. 11, 1968).

The cross-section ratios for the production of the isomeric pairs ^{80}Br^{m,g}, ^{91}Mo^{m,g}, ^{112}In^{m,g}, ^{142}Sm^{m,g} through the (n,2n) reaction have been measured by the activation method. The experimental data of this work and those available from the literature have been analyzed by the Huizenga-Vandenbosch method and the spin cut-off parameter has been extracted. (auth)

24873 SELECTED FISSION CROSS SECTIONS FOR ^{232}Th, ^{233}U, ^{234}U, ^{235}U, ^{236}U, ^{237}Np, ^{238}U, ^{239}Pu, ^{240}Pu, ^{241}Pu, AND ^{242}Pu. Davey, William G. (Argonne National Lab., Idaho Falls, Idaho). Nucl. Sci. Eng., 32: 35-45(Apr. 1968).

The fission cross sections of ^{232}Th, ^{233}U, ^{234}U, ^{235}U, ^{236}U, ^{237}Np, ^{238}U, ^{239}Pu, ^{240}Pu, ^{241}Pu, and ^{242}Pu from 1 keV to 10 MeV published up to July, 1965, were analyzed previously to select best fission cross sections for fast-reactor analysis. Since the completion of that work, new data have been produced which necessitate reevaluation of the fission cross sections particularly in the region 1 to 5 MeV. The revised data presented here are believed to be of greater consistency and, hence, accuracy than the previous selection. (auth)

24874 SHORT-LIVED ISOMERS EXCITED BY 10-MeV-PROTON IRRADIATIONS. Ivanov, E. A. (Inst. of Atomic Physics, Bucharest). Rev. Roum. Phys., 12: 885-9(1967).

A pulsed-beam experiment with 10 MeV protons on natural targets was carried out and twelve short-lived isomers were observed. The gamma-transition energies as well as the half-lives of the isomeric decays are reported. (auth)

24875 YIELD AND ANGULAR ANISOTROPY OF FRAGMENTS FROM PHOTOFISSION OF ^{226}Ra. Zhagrov, E. A.; Nemilov, Yu. A.; Selitskii, Yu. A. Yadern. Fiz., 7: 264-8(Feb. 1968). (In Russian).

Fractional yields of the ^{226}Ra photofission were measured for the endpoint energies from 9 up to 25 MeV. On basis of the data on ^{238}U, the energy dependence of the photofission yield per roentgen for ^{226}Ra was plotted. The photofission threshold for ^{226}Ra is found to be 8.5 ± 0.5 MeV. Angular distributions of fragments were measured at various energies. The result is that for equal values of $E_0 - B_f$ (B_f is the photofission threshold, E_0 is the endpoint energy of the bremsstrahlung spectrum), the anisotropy for Ra is less than that for Th. The energy dependence of the anisotropy coefficient α for ^{226}Ra is presented. (auth)

24876 RESONANCE PARAMETERS FOR ^{236}U FROM INTEGRAL MEASUREMENTS. Baumann, N. P.; Halford, J. D.; Pellarin, D. J. (E. I. du Pont de Nemours and Co., Aiken, S. C.). Contract AT(07-2)-1. Nucl. Sci. Eng., 32: 265-7(1968). (DP-MS-67-83).

The resonance integral for neutron capture in ^{236}U was determined by comparing the absolute counting rates of simultaneously irradiated cadmium-covered ^{197}Au foils and ^{236}U foils. The self-shielding effects for ^{236}U foils with thicknesses of 2 to 100 mg/cm^2 were also investigated, as was the energy distribution of neutron resonance absorptions in ^{236}U. (D.C.W.)

24877 THE HALF-LIVES OF THE 289- AND THE 1513-keV LEVELS IN ^{156}Gd. Walter, H. K.; Weitsch, A. (Technische Hochschule, Darmstadt, Ger.). Z. Phys., 211: 304-11(1968). (In German).

The half-lives of the 289- and the 1513-keV levels in ^{156}Gd were measured by delayed coincidence techniques. (auth)

24878 SINGLE-PARTICLE NEUTRON STATES IN ^{211}Pb. Armstrong, D. D. (Los Alamos Scientific Lab., N. Mex.); Bernstein, E. M. Phys. Rev. Lett., 20: 936-8(Apr. 22, 1968). (LA-DC-9475).

The excitation functions for the ^{208}Pb(t,p) reaction at triton energies of 14 to 17 MeV were measured. Anomalies were observed at 16, 16.3, and 17, which correspond to the analogs of the $d_{\frac{3}{2}}$, $s_{\frac{1}{2}}$, and $d_{\frac{5}{2}}$ states in ^{211}Pb. (D.C.W.)

24879 ISOTOPIC DISTRIBUTION OF Rb AND Cs PRODUCED BY 10.5-GeV PROTONS ON U, Th, Ta, AND IDENTIFICATION OF NEW ISOTOPES: ^{77}Rb, ^{78}Rb, ^{120}Cs, ^{121}Cs, ^{122}Cs, AND ^{124}Cs. Klapisch, R. (Institut de Physique Nucleaire, Orsay, France. Centre de Spectrometrie Nucleaire, Orsay, France. Spectrometrie de Masse, Orsay, France); Chaumont, J.; Jastrzebski, J.; Bernas, R.; Simonoff, G. N.; Lagarde, M. Phys. Rev. Lett., 20: 743-5(Apr. 1, 1968).

Relative cross sections for the production of Cs and Rb isotopes in the proton spallation of Ta and the proton fission of Th and U at an incident proton energy of 10.5 GeV were measured. ^{78}Rb and ^{79}Rb were identified among the spallation products of Ta; ^{119}Cs, ^{120}Cs, ^{121}Cs, ^{122}Cs, and ^{124}Cs were also identified. (D.C.W.)

24880 POTENTIAL-ENERGY EFFECTS IN HEAVY-ION TRANSFER REACTIONS. Diamond, R. M.; Poskanzer, A. M.; Stephens, F. S.; Swiatecki, W. J.; Ward, D. (Univ. of California, Berkeley). Phys. Rev. Lett., 20: 802-5(Apr. 8, 1968). (UCRL-18013).

The ratio of yields for a single proton transferred into versus out of a projectile in reactions involving four different heavy projectiles on each of five heavy targets was measured. There is a strong preference to transfer the proton out of the projectile, which can be understood in terms of the potential energy of the two nuclei near contact. (auth)

24881 M1 AND E1 RESONANT SCATTERING OF GAMMA RAYS FROM NEUTRON CAPTURE IN IRON. Moreh, R.; Friedman, M. (Nuclear Research Centre, Beer-Sheva, Israel). Phys. Lett., 26B: 579-80(Apr. 1, 1968).

The parities of levels excited by resonance scattering of γ rays from neutron capture in iron were measured with a Compton polarimeter. The spins and parities of resonance levels in four isotopes were thus found to be ^{208}Pb(7.279 MeV, 1$^-$), ^{112}Cd(7.632 MeV, 1$^-$), ^{141}Pr(7.632 MeV, $\frac{1}{2}^-$), and ^{62}Ni(7.646 MeV, 1$^-$), which correspond to E1, M1, E1, and M1 radiation, respectively. These results disagree with Axel's suggestion that these resonances may be associated with the tail of the electric giant dipole resonance. (auth)

24882 MAGNETIC MOMENT OF A TWO-QUASIPARTICLE STATE IN ^{182}W. Bhattacherjee, S. K.; Bowmann, J. D.; Kaufmann, E. N. (California Inst. of Tech., Pasadena). Contract AT(04-3)-63. Phys. Lett., 26B: 583-4(Apr. 1, 1968).

The magnetic moment of the $I^\pi = 2^-$ two-quasiparticle state at 1289 keV in ^{182}W was measured to be $\mu = 1.04 \pm 0.24$ nm. (auth)

24883 MIXING OF CORE EXCITATIONS INTO THE SINGLE-NEUTRON STATES OF ^{207}Pb. Hering, W. R.; Achterath, A. D.; Dost, M. (Max-Planck-Institut fuer Kernphysik, Heidelberg). Phys. Lett., 26B: 568-70(Apr. 1, 1968).

The orbital angular momenta l and reduced widths of the neutron one particle–two hole components of nine states between 2.73 and 5.23 MeV in ^{207}Pb were measured in Coulomb stripping. Strong configuration mixing with 2^+ and 4^+ core excited states is found. (auth)

24884 HALF-LIFE OF THE FIRST EXCITED STATE IN ^{143}Pm. Heyde, K.; Dorikens, M.; Demuynck, J.; De Frenne, D.; Uyttenhove, J.; Dorikens-Vanpraet, L. (Rijksuniversiteit, Ghent). Phys. Lett., 26B: 571-2(Apr. 1, 1968).

The half-life of the first excited state in ^{143}Pm with $J^\pi = \frac{7}{2}^+$, measured by the technique of delayed coincidences as $T_{\frac{1}{2}} = 1.06 \pm 0.08$ ns gives support to the very pure one-quasiparticle character of this level. (auth)

24885 DECAY OF ^{174}Tm. Gujrathi, S. C.; Mukherjee, S. K. (Saha Inst. of Nuclear Physics, Calcutta). Indian J. Phys., 41: 667-76(Sept. 1967).

The ^{174}Tm nucleus is produced by ^{174}Yb (n,p) ^{174}Tm reaction with 14.8-MeV neutrons on enriched (99%) Yb isotope and is studied by means of beta-gamma scintillation counter techniques. The beta and gamma measurements show beta groups of endpoint energies 1200 ± 50 (82%) and 700 ± 50 (18%) keV and gamma rays of energies 50 (Yb K x-ray), 75, 175, 275, 350, 370, 500, 630, 870, 990, 1260, and 1350 keV decaying with a 5.5 ± 0.5-min activity of ^{174}Tm. The gamma-gamma coincidence studies confirm previously reported gamma-ray cascades along with a new cascade of 500-1350-275-75 keV. The gamma spectrum in coincidence with the beta rays above 300 keV shows the existence of the previously unreported 1350-keV gamma transition in the new cascade and also gives the 870-keV gamma transition between the 2380-keV level and the 1510-keV isomeric state of ^{174}Yb. A decay scheme of ^{174}Tm is proposed, and the results are compared and discussed in the light of the unified model and the pairing correlation model. The (n,p) cross section for ^{174}Yb is found to be 3.5 ± 1 mb. (auth)

24886 DECAY OF ^{176}Tm AND LEVELS OF ^{176}Yb. Gujrathi, S. C.; Mukherjee, S. K. (Saha Inst. of Nuclear Physics, Calcutta). Indian J. Phys., 41: 633-45(Sept. 1967).

The ^{176}Tm nucleus is produced by the (n,p) reaction with 14.8-MeV neutrons on enriched (97.5%) ^{176}Yb. A half-life of 1.4 ± 0.2 min is assigned to ^{176}Tm. The beta and gamma measurements show three beta groups of endpoint energies 3050 ± 100 (20%), 2000 ± 100 (40%), and 1150 ± 100 (40%) keV and eight gamma rays of energies 50 (Yb K X-ray), 91, 190, 285, 390, 870, 1050, and 1816 keV decaying with a 1.4-min activity of ^{176}Tm. Coincidence and sum spectrum studies indicate that the 1150-keV beta group is in coincidence with a gamma-ray energy cascade 870–1816–190–50 keV; the 200-keV beta group is in coincidence with the 1050-keV gamma ray and a gamma-ray energy cascade 1816–190–50 keV; and the 3050-keV beta group is not in coincidence. The 91-, 390-, 285-, 190- and 50-keV gamma rays form a cascade. A decay scheme of ^{176}Tm is proposed, and the results are discussed in the light of the unified model. The Q_β value for the ^{176}Tm–^{176}Yb transition is 4088 ± 100 keV. The (n,p) cross section for ^{176}Yb is found to be 1.5 ± 0.5 mb. (auth)

24887 ISOTOPE SHIFT MEASUREMENTS USING K X RAYS IN Sn, Sm, AND W. Chesler, Ronald Benjamin. Pasadena, Calif., California Inst. of Tech., 1967. 113p. Thesis.

Electronic Kα1 x-ray isotope shifts were measured for $^{118-124}$Sn, $^{148-154}$Sm, $^{182-184}$W, $^{184-186}$W, and $^{182-186}$W using a curved crystal Cauchois spectrometer. The analysis of the measurements included the electrostatic volume effect, screening by the transition electron as well as the nontransition electrons, normal and specific mass shifts, dynamical nuclear quadrupole polarization, and a radiative correction effect of the electron magnetic moment in the nuclear electric field. Results for the isotopic changes in the nuclear charge radii are obtained. Where other experimental data are available, the agreement with the present measurements is satisfactory. Comparisons with several nuclear model predictions yield only partial agreement. (Disser. Abstr.)

Nuclear Theory

Refer also to abstracts 24570, 24825, 24828, 24829, 24840, 24846, 24847, and 24866.

24888 (BMwF-FBK-67-91) TABELLEN DER Q-WERTE FUER DREITEILCHEN-REAKTIONEN AN DEN KERNEN ^{2}H BIS ^{48}Ca. (Tables of Q Values for Three-Particle Reactions on the Nuclei ^{2}H to ^{48}Ca). Buschmann, H. T.; Klein, H.; Kuhlmann, W.; Stehle, H. (Cologne Univ. (West Germany). Institut fuer Kernphysik). Dec. 1967. 94p. (In German). Dep.

Q-values for three-particle reactions were calculated; the results are summarized in tables. The incident particles considered were neutrons, protons, deuterons, tritons, ^{3}He, ^{4}He, ^{6}Li, and ^{7}Li on targets of T and the stable nuclei D to ^{48}Ca. Reactions with two light outgoing particles were selected; all the three-particle reactions leading to the same final nucleus are summarized. (D.C.W.)

24889 (BMwF-FBK-67-93) KERNZUSTAENDE UND KERNREAKTIONEN IM VERALLGEMEINERTEN CLUSTERMODELL. (Nuclear States and Nuclear Reactions in the Refined Cluster Model). Hackenbroich, H. H. (Tuebingen Univ. (West Germany). Institut fuer Theoretische Physik). Dec. 1967. 70p. (In German). Dep.

Mathematical methods that can be used to describe nuclear bound states and reactions, starting from realistic nucleon-nucleon forces, are described. The methods are based on the approximation of the nuclear wave functions by a superposition of cluster functions. (D.C.W.)

24890 (IAE-1316) EKVIVALENTNYI LOKAL'NYI POTENTSIAL. (Equivalent Local Potential). Gorodkov, S. S. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Atomnoi Energii). 1967. 9p. (In Russian). Dep.

Problems of the equivalent local potential were solved on the assumption of slowly changing potentials in the first approximation. The Perey effect formula was theoretically verified. The suitability of the Perey–Buck formulas in very high approximations was shown. The radius of the equivalent local potential of the Saxon–Woods form was found. (tr-auth)

24891 (INR-854/VII/PL) THE NUMERICAL PROGRAM OF THE DIAGONALIZATION OF THE NILSSON MODEL IN GIER-ALGOL. Zielinska-Pfabe, M.; Grochulski, W. (Institute of Nuclear Research, Warsaw (Poland)). 1967. 18p. Dep.

The description of the numerical computation program for a diagonalization of the Nilsson model of atomic nucleus is given. The computation contains two cases: the old Nilsson model (Kgl. Danske V. S., Mat.-Fys. Medd., 29., No. 16, 1955) and a slightly modified version suggested recently. The calculation is limited to the case of axial symmetry. The eigenvectors and eigenvalues can be obtained for any quadrupole and hexadecapole deformation. Both programs are written in Gier-Algol. (auth)

24892 (IPNO/TH-121) GENERALIZED SENIORITY BREAKING OF TWO BODY INTERACTIONS. Bohigas, O.; Quesne, C.; Arvieu, R. (Paris Univ., Orsay (France). Institut de Physique Nucleaire). Feb. 1968. 15p. Dep.

An expansion of the two-body potential in three parts which participate differently in the breaking of the generalized seniority is derived. The magnitude of each term is calculated for most of the interactions used recently in shell model calculations. The term which has only diagonal elements in the generalized seniority scheme is found to be by far the largest. (auth)

24893 (ITF-67-44) PARTICLE IN NUCLEAR-COULOMB FIELD (THE FREDHOLM THEORY). Mentkovskii, Yu. L. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1967. 39p. Dep.

The rigorous Rayleigh-Schrödinger perturbation theory and the Lippmann-Schwinger theory for particles in a nuclear-Coulomb field are constructed on the basis of a Fredholm integral equation for partial waves. (auth)

24894 (JINR-E4-3703) EQUILIBRIUM DEFORMATIONS OF THE GROUND AND EXCITED STATES OF STRONGLY DEFORMED NUCLEI. Arseniev, D. A.; Malov, L. A.; Pashkevich, V. V.; Soloviev, V. G. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1968. 31p. Dep.

The equilibrium deformations for nuclei were calculated and the dependence of the energy on the deformation parameters β and γ was studied. It is shown that for strongly deformed nuclei, the total energy has two minima depending on β for $\gamma = 0$: at $\beta_0 = 0.2$ to 0.3 (with the energy 4 to 8 MeV with respect to the nuclear energy, at $\beta = 0$) and at $\beta_0 = 0.1$ to 0.2 (with the energy 1.5 to 5 MeV). While studying the behavior of the total energy $E(\beta,\gamma)$ as a function of the parameters β and γ, it was found that this function has only one minimum at $\gamma = 0$ and $\beta \approx 0.2$ to 0.3. Investigation of the equilibrium deformations of the excited states have shown that there exist no excited states with the equilibrium deformation $\beta_e < 0$ while for the ground state $\beta_0 > 0$. The conclusions mentioned refer to the deformed nuclei, far from the transition region. For the nuclei of the transition region, the deformation of the excited states may differ considerably on β as well as on γ from that of the ground state. (auth)

24895 (JINR-E4-3742) REACTIONS WITH TRANSFER OF TWO PARTICLES. Rotter, I. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1968. 13p. Dep.

A formula is given for the spectroscopic factor determining the excitation of any level of the final nuclei in reactions between complex nuclei. All intermediate states which are formed by the transferred nucleons and which are compatible with the quantum numbers of the nuclei are taken into account. The reactions (^{6}Li,α) and (^{18}F,^{16}O) on light nuclei are considered in more detail. (auth)

24896 (LA-DC-8192) SHELL MODEL THEORY OF NUCLEAR INTERMEDIATE STRUCTURE. Young, J. E. (Los Alamos Scientific Lab., N. Mex.); Zuker, A. (Oxford Univ. (England). Dept. of Theoretical Physics). [1966]. Contract W-7405-eng-36. 13p. Dep. CFSTI.

A microscopic theory of intermediate structure, which relates proton inelastic scattering to (d,p) reactions, is outlined. (D.C.W.)

24897 (LYCEN-6784) SYMETRISATION DES INTERACTIONS DANS LES COLLISIONS DE REARRANGEMENT PAR APPLICATION DE LA TRANSFORMATION DE FOURIER GENERALISEE. (Symetrisation of Interaction in Rearrangement Collisions Through the Application of General Fourier Transforms). Guyaux, Jean (Lyon Univ. (France). Institut de Physique Nucleaire). Dec. 1967. 131p. (In French). Dep.

Thesis.

The study of the symmetrization of the interactions in rearrangement collisions is based on the concept that every reaction is, at the least, a three-body problem. The Schroedinger equation is therefore rewritten in the center-of-mass system. The solutions of the corresponding homogeneous equation permits a development of the wave function which is its Fourier transform in a six-space dimension. Development of the formal theory of scattering in the Hilbert space establishes that the potentials intervening in the transition matrix are three in number. The interaction is thus symmetrized. This symmetrization requires the decomposition of the initial (and final) state on the chosen base. These theoretical studies are then applied to the reactions ^{28}Si(d,p)^{29}Si and ^{16}O(d,p)^{17}. (J.S.R.)

24898 (BNL-tr-203) INDUCED CAPTURE OF ORBITAL ELECTRON. Mikaelyan, L. A.; Tsinoev, V. G.; Borovoi, A. A. Translated by Stephen J. Amoretty (Brookhaven National Lab., Upton, N. Y.), from Yad. Fiz., 6: 349-52(1967). 10p. Dep. CFSTI. JCL $1.10 fs, $0.80 mf.

The resonance capture of the orbital electron induced by the electron antineutrino is considered. For the allowed transitions, an expression is derived for the cross section averaged over the reactor $\bar{\nu}_e$ spectrum. For heavy nuclei, the cross section of the process considered exceeds the cross section of the "usual" inverse β decay $\bar{\nu}_e + A_1 \rightarrow A_{z-1} + e^+$. (auth)

24899 SPIN-SPIN INTERACTION IN AN OPTICAL POTENTIAL AND EXCITATION OF ANALOG STATES DURING QUASIELASTIC SCATTERING. Vysotskii, G. L.; Chegoryan, M. A. (Physical-Technical Inst., Kharkov). Ukr. Fiz. Zh., 12: 2071-3(Dec. 1967). (In Russian).

The polarization of final nuclei induced by quasielastic scattering accompanied by the excitation of isobaric analog states was examined in order to determine the spin dependence of the optical potential. This may be done because, in contrast to elastic scattering, in this process the polarization can be measured by the circular polarization of γ quanta emitted by the final nuclei. The optical potential selected for consideration contained an isotopic-spin dependent term. The Coulomb interaction was neglected so that the calculation was not expected to yield a quantitative description of the process. It was found that the polarization of the final nucleus did depend on the spin-spin and spin-orbit portions of the optical potential. The expression which connects this polarization with the circular polarization of the emitted γ quanta was derived. (TTT)

24900 CORRELATION OF DIFFERENTIAL CROSS SECTION AND POLARIZATION DURING PROTON ELASTIC SCATTERING. Prokopenko, V. S.; Pucherov, N. N. (Inst. of Physics, Kiev). Ukr. Fiz. Zh., 12: 2078-80(Dec. 1967). (In Russian).

An attempt was made to correlate the polarization of elastically scattered nucleons with the corresponding differential cross-section data. The polarization, P, was assumed to be related to the differential cross section, σ, by the expression: $P = A[(\sigma/\sigma_R)'/(\sigma/\sigma_R)] + B$, where σ_R is the Rutherford differential cross section, and A and B are two free parameters which were allowed to vary. Angular distribution data were fitted for the polarization of 14.5- and 17.8-MeV protons scattered from 16 target nuclei ranging from ^{32}S to ^{120}Sn. Good fits were obtained except for data at large angles. For a large number of targets the parameter A was close to 0.1 and and B was nearly zero. Thus, if differential cross-section data are available, a good estimate of the polarization of scattered nucleons can be obtained by using the above expression and by setting A = 0.1 and B = 0. (TTT)

24901 PURITY OF NUCLEAR COLLECTIVE EXCITATION SPECTRA OF EVEN NUCLEI. Murthy, A. S. Venkatesha (Karnatak Univ., Dharwar, India). J. Karnatak Univ., No. 9-10, 1-4(1964-65).

Grechukhin (Nucl. Phys., 40: 422(1963)) has estimated experimentally the purity of nuclear states by comparing the experimental and theoretical δ^2(E2/M1), assuming the hydrodynamical model for which $Z/g_R = A$. Though the observed derivations of the experimental value from theory estimates can be ascribed to impurity of collective states, they can also be due to the assumption $Z = g/R_A$. An attempt has been made to verify the latter by comparing the two quantities δ^2(E2/M1) for different transitions where Z/g_R does not enter. It is observed that ^{56}Fe, ^{82}Kr, and ^{192}Pt are in good agreement with theory showing the purity of the nuclear collective excitations and that large derivations from theoretical values occur when the transition energy (W) > about 1 MeV, and δ^2 exp < 0.6 whenever W > 1 MeV. (Indian Sci. Abstr.)

24902 TO THE PROBLEM OF INVERSE RELATION BETWEEN THE DENSITY OF NUCLEAR MATTER AND THE SHELL-MODEL POTENTIAL. Nemirovskii, P. E. Yadern. Fiz., 7: 289-91(Feb. 1968). (In Russian).

The relation between the optical potential and the density of the nuclear matter is considered. It is shown that the dependence of the potential on r can be obtained for various nuclei from radial dependence of the density by means of integral transformation with two constants which are the same for all magic nuclei. (auth)

24903 ON ROLE OF THE EXCHANGE MAJORANA FORCES IN PARTICLE-HOLE DIPOLE TRANSITIONS. Dzhibuti, R. I.

(Inst. of Physics, Tbilisi, USSR). Yadern. Fiz., 7: 298-302(Feb. 1968). (In Russian).

The contribution from velocity-dependent terms in the nucleon-nucleon interaction potential to the total nuclear photoabsorption cross sections is calculated. The contribution from the exchange Majorana potential to the probability of particle-hole dipole transitions is shown to be substantial. (auth)

24904 MAGNETIC MOMENTS OF DEFORMED NUCLEI. Chernyshev, A. S.; Rapoport, L. P. (Voronezh State Univ., USSR). Yadern. Fiz., 7: 309-19(Feb. 1968). (In Russian).

Magnetic moments of deformed nuclei in the ground state with the odd atomic number $150 < A < 190$ and with spin $K \neq 1/2$ are considered with the method of the theory of finite Fermi systems. The effective spin gyromagnetic ratio has been calculated in the quasiclassical approximation as well as with a computer. In both cases, the effect of the spin polarization of the kernel is systematically underestimated, if in calculations one uses the value of the spin constant g_0 as obtained considering the magnetic moments of the spherical nuclei. A good agreement with the experiment is obtained if one takes for g_0 the value $g_0^{nn} = g_0^{pp} = 3.8$; $g_0^{np} = 0$. (auth)

24905 PSEUDOSCALAR INTERACTION IN BETA-DECAY. Chaku, K.; Sheth, C. V. (Karnatak Univ., Dharwar, India). J. Karnatak Univ., No. 9-10, 196-200(1964-5).

Investigations on the contribution due to pseudoscalar interaction in β decay are reviewed. The shape measurements in β transition $0^- \rightarrow 0^+$ of $^{144}Pr \rightarrow {}^{144}Nd$, performed by Graham, Geiger, and Eastwood (Can. J. Phys., 36: 1084(1958)), give an upper limit for $C_p/C_A < 15$. Comparison of degrees of longitudinal polarization of high-energy monoenergetic electrons from $^{144}Pr \rightarrow {}^{144}Nd(0^- \rightarrow 0^+)$ and the allowed $^{106}Rb \rightarrow {}^{106}Pd(1^+ \rightarrow 0^+, 2^+)$ was done by Cohen and Weiner (Nucl. Phys., 15: 79(1960)). They obtain an upper limit for $/C_p/C_A/ \leq 20$. It is seen according to argument of Blokhintsev and Dolinsky (Nucl. Phys., 34: 490(1962)) that the contribution due to induced pseudoscalar interaction is absent for high Z as predicted by Tadic (Nucl. Phys., 26: 338(1961)). The longitudinal polarization of β rays emitted in the transition $^{207}Tl \rightarrow {}^{207}Pb$ ($1/2^+ \rightarrow 1/2^-$) was measured by Cuperman (Phys. Rev., 107: 1459(1957)), and it is shown that the contribution due to pseudoscalar interaction is small if any. (Indian Sci. Abstr.)

24906 TO THE ANALYSIS OF 2-FORBIDDEN β TRANSITIONS. Kopytin, I. V.; Berkman, M. I. (Voronezh State Univ., USSR). Yadern. Fiz., 7: 330-1(Feb. 1968). (In Russian).

The shape of the β spectrum and lg ft are calculated for the second-forbidden β transitions on basis of a more realistic estimate for the ratio of the velocity nuclear matrix element to the normal matrix element than the estimate by Fujita accepted till now. (auth)

24907 ALLOWED β TRANSITIONS IN THE WIGNER SUPERMULTIPLET APPROXIMATION. Petrauskas, A. K.; Vanagas, V. V. (Inst. of Physics and Mathematics, Vilnyus, USSR). Yadern. Fiz., 7: 324-9(Feb. 1968). (In Russian).

It is shown that in the Wigner supermultiplet approximation, matrix elements for the allowed β transitions do not depend on the detailed form of the orbital wave function. Explicit formulas for the calculation of matrix elements of the operators for the allowed β transitions are obtained. Calculated ft values for the superallowed transitions between the analog states with $T = 1/2$, 1, 3/2 for a series of nuclei are compared with the experiment. (auth)

24908 CALCULATION OF CORRELATIONS BETWEEN CHARACTERISTICS OF EVAPORATED PRODUCTS FROM NUCLEAR DISINTEGRATION WITH FRAGMENTS. Azimov, S. A.; Karimova, R.; Lozhkin, O. V. (Inst. of Nuclear Physics, Tashkent). Yadern. Fiz., 7: 332-9(Feb. 1968). (In Russian).

The calculation is based on the cascade-statistical model of the nuclear fission with the assumption that the fragment is emitted while the first period of the nuclear evaporation. The "evaporation" stage is calculated by the Monte-Carlo method of the nuclei ^{108}Ag and ^{80}Br at the incident proton energy 660 MeV. The calculated characteristics are compared with the experimental ones. The results of the comparison show that the fragmentation model used in the present work is invalid even if applied to the fragments with energy less than 4 MeV/nucleon. (auth)

24909 MODIFICATION OF THE OPTICAL MODEL. Aver'yanov, I. K.; Purtseladze, Z. Z. Yadern. Fiz., 7: 283-8(Feb. 1968). (In Russian).

A local optical model for nucleons is presented. The model has only five free parameters. The computed cross sections and polarizations are in reasonable agreement with the experimental data. (auth)

24910 HYDRODYNAMICAL OR DROP MODEL OF THE NUCLEUS. Nevzglyadov, V. G. Vestn. Leningrad. Univ., No. 19, Ser. Mat., Mekh. Astron., No. 4, 114-23(Oct. 1967). (In Russian).

According to the theory of homogeneous deformation body (h. d. body) inertial deformation of the h. d. body is considered. In the absence of rotation (vortex-free motion) the Lagrangian function and accordingly the equations of motion are the same as in O. Bohr's theory. A motion corresponding to O. Bohr's model is found; this motion is called "pure rotation of the deformation axes." A comparison with the Bohr's "wave rotation" and the Zhukorskii "elliptical rotation" is made. (auth)

24911 SELF-INDICATION IN AREA ANALYSIS OF NEUTRON RESONANCES. II. CORRECTIONS. Fleck, C. M.; Weisshaeupl, H. A. (Atominstitut der Oesterreichische Hochschule, Vienna). Nucl. Instrum. Methods, 61: 53-7(Apr. 15, 1968).

For the self-indication in area analysis the corresponding corrections for wing contribution, multi-level effects, and expansion errors are calculated in detail. (auth)

24912 SELF-INDICATION IN AREA ANALYSIS OF NEUTRON RESONANCES. I. METHOD. Fleck, C. M.; Weisshaeupl, H. A. (Atominstitut der Oesterreichische Hochschule, Vienna). Nucl. Instrum. Methods, 61: 45-52(Apr. 15, 1968).

The self-indication method for the determination of the neutron resonance parameters σ_r and Γ is applied to thin foils. Thus the corrections for multiple interactions, 1/v-term, energy dependence of the flux and interference terms, which become more and more important with increasing foil thickness, can be avoided. The flux and the detector efficiency are eliminated by standardization to the reaction rate of the unshielded detector sample. An additional equation for evaluating σ_r and Γ is obtained by a variation of the temperature. Formulas for absorber and detector held both at the same and at different temperatures are given in detail, treated for the most part analytically. (auth)

24913 THE TWO-PARTICLE CORRELATION FUNCTION IN A FINITE FERMI GAS MODEL. Bogan, A. Jr.; Foldy, L. L. (Case Western Reserve Univ., Cleveland). Nucl. Phys., B4: 485-500(1968).

The properties of $F(\nu)$, the one-dimensional analog of the Fourier transform of a certain two-particle correlation function of interest in the theory of muon capture by nuclei (as well as other situations), were investigated for various models. The models consist of N independent particles in a one-dimensional box of finite size, and the models differ in the boundary conditions imposed at the edges of the box. The functions $F(\nu)$ for these models, for the infinite Fermi gas model and for a "finite Fermi gas" model are compared and found to differ substantially. As the number of particles in the box increases, the difference between $F(\nu)$ for each of the models and $F(\nu)$ for the infinite Fermi gas vanishes, but the magnitude (and sign) of this difference depends strongly upon the nuclear model. Because of the finite nuclear size, $F(\nu)$ must possess a power series expansion in ν^2, a property not shared by the infinite Fermi gas model, but the coefficient of ν^2 is again found to depend strongly upon the nuclear model. (auth)

24914 EFFECT OF COULOMBIC DISTORTION IN REACTIONS OF THE TYPE (l,l'p). Meboniya, D. V. Vestn. Mosk. Univ., Ser. III. Fiz. Astron., No 2, 112-15(Mar.-Apr. 1967). (In Russian).

Since electrons do not "feel" the nuclear potential, the cross section of the (e,e'p) process can always be factored into a cross section for free electron scattering on a proton and a distorted momentum distribution of protons in the nucleus. A direct connection can be established between the Coulombic distortion and the distorted momentum distribution. The effect of Coulombic distortion on the differential cross-section can be characterized by a suppression factor R_l which is determined mainly by the imaginary part of the optical potential. The nuclear potential is described as a Gaussian function and also as a Woods–Saxon function. Concrete calculations were carried out for coplanar (e,e'p) scattering on a ^{40}Ca nucleus with knocking-out of protons from 1s, 1p, 1d, and 2s shells. The functions of a harmonic oscillator were used as single-particle wave functions. The following kinematic parameters were selected: bombarding electron energy $E_0 = 520$ to 600 MeV, transmitted energy at 110 MeV, electron scattering angle $\theta_e = -51°$, and proton emission angle $\theta_p = 49°$ at $q = 0$. The suppression factors R_{1s} and R_{2s} are given as functions of the optical potential parameters. The results of the calculations show that the quasiclassical method is sufficiently accurate in taking into account the Coulombic distortion in (e,e'p) reactions at high energies. Taking into account the Coulombic distortion leads to an additional decrease in suppression factors of about 5 to 9%. (TTT)

24915 METHOD FOR THE CALCULATION OF NEUTRON-CAPTURE GAMMA-RAY SPECTRA. Yost, K. J. (Oak Ridge National Lab., Tenn.). Nucl. Sci. Eng., 32: 62-75(Apr. 1968). (ORNL-P-3408).

A model suitable for the prediction of gamma-ray spectra subsequent to the capture of neutrons into nuclear states of identifiable

spin and parity was developed. The dependence of radiative transition probabilities on the nuclear selection rules is explicitly accounted for. Means are provided for allowing dipole and quadrupole transitions in conjunction with variations in the magnitudes of corresponding transition "matrix elements." Comparisons are given between experimental capture spectra and corresponding spectra calculated with varying assumptions with respect to pertinent nuclear parameters for two capture states of ^{28}Al and one of ^{25}Mg. A comparison of calculated spectra using fitted and crudely approximated cascade parameters for the ^{28}Al capture states indicates few, if any, differences that would significantly change resultant neutron-capture gamma-ray-production cross sections. (auth)

24916 STUDYING SCATTERING PROCESSES BY MEANS OF THE COLLISION LIFETIME MATRIX METHOD. Ol'khovskii, V. S. (Kiev State Univ.). Ukr. Fiz. Zh., 13: 143-51(Jan. 1968). (In Russian).

The definition of the collision lifetime matrix for elastic and inelastic scattering of spinless particles by an arbitrary scatterer is introduced and its properties are discussed. The connection between the collision lifetime matrix and the set of differential cross sections is considered on the basis of the unitarity relation. The preliminary study of nuclear collision processes by means of collision lifetime matrix enabled one to suppose the proposed method may be a rather convenient instrument of investigating metastable states which are displayed in the processes of scattering and decay. (auth)

24917 USES OF OPTICAL MODELS DESCRIBING ELASTIC SCATTERING OF 2.8 MeV NEUTRONS. Strizhak, V. I.; Korbetskii, E. V.; Sokolov, L. S. (Kiev State Univ.). Ukr. Fiz. Zh., 13: 152-4(Jan. 1968). (In Russian).

Differential cross sections of 2.8-MeV neutron elastic scattering on Mg, Al, S, Fe, Ni, Cu, Zn, Se, Zr, Mo, Cd, Sn, Sb, and Te nuclei were studied using optical models with local potentials. Calculations based on Bjorkkland–Fernbach potentials of 4.1 MeV with the parameters extrapolated to 2.8 MeV are tabulated and curves of the angular distribution of neutrons are constructed and analyzed. (R.V.J.)

24918 OPTICAL MODEL ANALYSIS OF ELASTIC SCATTERING AND NEUTRON–NUCLEUS POLARIZATION OVER THE 4-MeV RANGE. Kashuba, I. E.; Kozin, B. D. (Kiev Inst. of Physics). Ukr. Fiz. Zh., 13: 51-7(Jan. 1968). (In Russian).

A detailed analysis of experimental angular distributions of elastically scattered 4-MeV neutrons and nuclear polarizability over a wide range of mass numbers was carried out on the basis of local seven-parametric optical model with surface absorption. An isotopic dependence of the depth of a real part of the central potential and its diffusivity is found. (auth)

24919 INTERNAL CONVERSION TABLES. PART I. K-, L-, M-SHELL CONVERSION COEFFICIENTS FOR Z = 30 TO Z = 103. Hager, R. S.; Seltzer, E. C. (California Inst. of Tech., Pasadena). Contract AT(04-3)-63. Nucl. Data, Sect. A, 4: 1-235(Feb. 1968).

Values of the internal conversion coefficient, number of electrons per photon emitted in a nuclear transition, are presented from a new relativistic self-consistent-field calculation which takes into account finite nuclear size, hole and exchange effects, experimental electron binding energies, and vacuum polarization. Coefficients are given for each value of Z; for K, L, and M electron shells and L- and M-subshells; for nuclear transition multipolarities E1 ... E4, M1 ... M4; and for various nuclear-transition energies up to 1500 keV. A program for finding values for other energies by spline interpolation is appended. (auth)

24920 MULTICHANNEL UNITARY POLE RESONANCE FORM OF THE COLLISION MATRIX. Ullah, N.; Warke, C. S. (Tata Inst. of Fundamental Research, Bombay). Phys. Lett., 26B: 556-8(Apr. 1, 1968).

The unitary pole resonance form of the low energy collision matrix is presented, for the case of two overlapping resonances and an arbitrary number of channels, which contains only independent observable resonance parameters. This form is the same whether we start from R-matrix theory or Feshbach's unified theory. All the other resonance parameters, which are needed in almost all the formal reaction theories, can be expressed in terms of our independent resonance parameters. The level and channel sum rules are also given. (auth)

24921 GENERALIZED SENIORITY BREAKING OF TWO-BODY INTERACTIONS. Bohigas, O.; Quesne, C.; Arvieu, R. (CNRS, Orsay, France). Phys. Lett., 26B: 562-7(Apr. 1, 1968).

An expansion of the two-body potential in three parts which participate differently to the breaking of the generalized seniority is derived. The magnitude of each term is calculated for most of the interactions used recently in shell model calculations. The term which has only diagonal elements in the generalized seniority scheme is found to be by far the largest. (auth)

24922 CORRECTION TO SOME EXPERIMENTS TO MEASURE THE REORIENTATION EFFECT. Simpson, J. J.; Smilansky, U. (Weizmann Inst., Rehovoth, Israel). Phys. Lett., 26B: 581-2(Apr. 1, 1968).

The importance of the attenuation of the γ-ray angular distribution on the interpretation of reorientation experiments is discussed. The attenuation which arises when the emitting nuclei recoil into vacuum leads to an appreciable uncertainty in some reported quadrupole moments. (auth)

24923 NUCLEAR FORCES. INTRODUCTION TO THEORETICAL NUCLEAR PHYSICS. Eder, Gernot. Cambridge, Massachusetts Institute of Technology, 1968. 356p. $17.50.

Translated by Irving Kaplan.

An introduction to the methods that provide a unified view of the interactions of nuclear particles is presented, with emphasis on the methods currently used in theoretical nuclear physics. Two-nucleon systems, single-particle problems, many-body problems, nuclear reactions, and interactions of nucleons with other elementary particles are considered. (D.C.W.)

24924 NUCLEAR MATTER AND NUCLEAR REACTIONS. Kikuchi, Ken; Kawai, Mitsuji. A North-Holland Research Monograph in the Field of Nuclear Physics. New York, John Wiley and Sons, Inc., 1968. 341p.

Various statistical aspects of complex nuclei are described with emphasis on fundamental properties of nuclei as an ensemble of nucleons. A description is given of two-body collisions in nuclear matter on the basis of a semiclassical model, without using sophisticated mathematics, and of nuclear reactions at low and high energies with emphasis on high-energy reactions. (D.C.W.)

REACTOR TECHNOLOGY

Central Power Reactors

Refer also to abstracts 23173, 23175, 23204, 23247, 23709, 23722, 23768, 23853, 23855, and 25172.

24925 (ANL-7427) REACTOR DEVELOPMENT PROGRAM PROGRESS REPORT, FEBRUARY 1968. (Argonne National Lab., Ill.). Mar. 26, 1968. Contract W-31-109-eng-38. 151p. Dep. CFSTI.

REACTOR FUEL ELEMENTS—cladding materials for, compatibility with fuel carbides of; cladding materials for, tube-burst properties of; fuel motion in ceramic, effect of heat input from transient accidents on, (T); meltdown measurements on vibrationally compacted uranium oxide (UO_2) rods in TREAT

INCONEL 625—compatibility with carbide reactor fuels

REACTOR FUELS—preparation of carbides by fluidized-bed technique; production of ZPR, during Feb. 1968; radiation effects measurements on carbides

PLUTONIUM CARBIDES—preparation by fluidized-bed technique

CRITICAL ASSEMBLIES—neutron spectrum in ZPR-3 Assembly 51, central, (T); neutron spectrum in ZPR-6 Assembly 6 with and without sodium, central, (E); sodium-void coefficient measurements in ZPR-6 Assembly 6

SODIUM—oxygen determination in, techniques for; effects on wear properties of Clarite and Carboloy; carbon determination and recovery in; corrosive effects on metals, effects of dissolved getters on; heat transfer rates for metal sphere moving through liquid; superheat measurements on, effect of pressure-temperature history on; boiling of, temperature, pressure, and acoustic-noise variations at initial, (E)

TUNGSTEN CARBIDES—wear properties of, sodium effects on

EXPERIMENTAL BREEDER REACTOR-II—core changes in, reactivity changes from, (E); power coefficient measurements in; critical parameters for wet critical loading in, (E/T); reactivity feedback function for, oscillator and rod-drop values of, (E/T); control rod configurations in, reactivity worth of, (T); core configurations in, reactivity worth of, (T); reactivity change from subassembly expansion in, (T); fuel pin swelling in, effect of casting conditions on; fuel pin swelling in, effect of trace-element impurities on; coolant quality in, analysis and control of sodium; radiation testing experiments in, status of; superheater vibration frequency analysis in, (T); control rod drop tests in; fuel cycle facility operation for Feb. 1968; fuel element jacket deformation during bonding

URANIUM CARBIDES—preparation by fluidized-bed technique; PuC-UC, radiation effects measurements on

URANIUM ISOTOPES U-235—neutron fission rates in EBR-2, (E/T); neutron fission cross section measurements from 30 to 1500 keV

URANIUM ISOTOPES U-238—neutron fission rates in EBR-2, (E/T)

FISSIUM—fissium-U, swelling of irradiated, effect of heat treatment on

SILICON—effect on irradiation swelling of EBR-2 fuel

SELENIUM—neutron scattering and polarization measurements for, optical-model parameters fitting to, (E/T)

YTTRIUM—neutron scattering and polarization measurements for, optical-model parameters fitting to, (E/T)

URANIUM SULFIDES—radiation effects measurements on

NICKEL—corrosion in 650°C sodium, effect of magnesium solute on

LITHIUM—corrosive effects on tantalum at 1200°C, effects of iridium inhibitor on

PLUTONIUM OXIDES PuO_2—PuO_2-UO_2, radiation effects on, electron microprobe analysis of; PuO_2-UO_2, sintering behavior of, effect of stoichiometry on

THERMAL STRESSES—dynamic effects of heat-generation changes in solids, (T)

REACTORS—core structural dynamics in, displacement-time responses from flow tests on, (E/T)

PLUTONIUM—solubility in zinc and zinc-magnesium alloys

PLATES—stress analysis of involute, one- and two-dimensional transient, (T)

HEAT TRANSFER—correlation of rates for metal spheres moving through water and liquid sodium, (T)

FLUID FLOW—pressure-wave propagation speeds in air-water mixtures, (E/T)

REACTOR CONTAINMENT STRUCTURES—hydrodynamic response to high-energy excursions, (T) (H.D.R.)

24926 (APDA-214) QUARTERLY TECHNICAL PROGRESS REPORT ON AEC-SPONSORED ACTIVITIES, SEPTEMBER 15-DECEMBER 15, 1967. (Atomic Power Development Associates, Inc., Detroit, Mich.). Contract AT(11-1)-865. 122p. Dep. CFSTI.

TUBES—wastage rates in steam generators from sodium-water reaction

SODIUM—reactions with water in steam generators, tube wastage rates from; analysis for impurities, Rhometer development for; purification of, getters and regenerative processes for; scanning systems for use in liquid, development of ultrasonic; reactivity worth measurements in ZPR-3 and -4

CROLOY—wastage rate of the tubes of, from sodium-water reaction

INCOLOY 800—wastage rate of the tubes of, from sodium-water reaction

STAINLESS STEEL—wastage rate of tubes of Type 321, from sodium-water reaction

IRON—determination in residues from Croloy tube corrosion by sodium-water reaction

HYDROGEN—evolution rate from sodium-water reaction on Croloy tubes, (T); determination in sodium, sensitivity of methods for

OXYGEN—determination in sodium, Rhometer development for

TRANSDUCERS—development of ultrasonic, for under sodium scanning

LEAD TITANATES—$PbTiO_3$-$PbZrO_3$, diffusion bonding to Monel

SEALS AND GLANDS—vacuum testing of, for under sodium scanner

FERMI FAST BREEDER REACTOR—development of, compilation of experiences during

FAST FLUX TEST FACILITY—design of, FTR safety studies for

FAST TEST REACTOR—fuel meltdown accidents in, analysis of energy release from

CRITICAL ASSEMBLIES—reactivity worths and reaction rate ratios calculated for ZPR-3 and -4

PLUTONIUM ISOTOPES Pu-239—alpha value evaluation for sodium reactivity measurements, (E/T); neutron fission cross sections from 0.1 to 10 keV

REACTOR SAFETY—fuel meltdown accidents in Fast Test Reactor, analysis of energy release from (H.D.R.)

24927 (APDA-306) SODIUM SAMPLING IN THE ENRICO FERMI ATOMIC POWER PLANT. Madsen, E. F. (Atomic Power Development Associates, Inc., Detroit, Mich.). Mar. 1968. Contract AT(11-1)-865. 99p. Dep. CFSTI.

The sampler designs used over the years in the primary sodium system of the Enrico Fermi Atomic Power Plant are described in detail. These include the earlier thief type as well as the present permanent flowthrough station. The cleaning procedures, sampling procedures, and analytical results are presented as the basis for evaluating the adequacy of the designs. (auth)

24928 (APDA-NTS-13) EVALUATION OF NOISE ANALYSIS FOR THE ENRICO FERMI REACTOR. Batch, M. L.; Klickman, A. E. (Atomic Power Development Associates, Inc., Detroit, Mich.). Jan. 1968. 90p. Dep. CFSTI.

The evaluation was made by reducing and analyzing sample data obtained from the heat-generating half of the primary system at three power levels: 0.05 MW(t), 56 MW(t), and 88 MW(t). The analysis of results covered the following aspects: search for indications of instability; examination of power spectral distribution of various signals; measurement of the amplitude of the transfer function between various parameters; measurement of the time lag between the various parameters; and measurement of the relative amount of coherent signal between input and output parameters. The most significant specific results are: flow variation is the major contributor to power fluctuation; the power spectral density of core power is greater under 2-loop (Loops 1 and 2) than 3-loop operation; and measured transfer functions and time lags support a nonmixing-type flow in the upper plenum with little or no channeling. (auth)

24929 (APDA-NTS-15) SCRAM TESTS TO DETERMINE SHUTDOWN TRANSIENT CHARACTERISTICS OF THE ENRICO FERMI REACTOR AND ASSOCIATED HEAT TRANSPORT SYSTEM. Ziniuk, M. A.; Wilber, H. A. (Atomic Power Development Associates, Inc., Detroit, Mich.). Apr. 1968. 45p. Dep. CFSTI.

Scram tests were performed at nominal reactor power levels of 9.5, 13.3, 20, and 67 thermal megawatts. During the 9.5-, 13.3-, and 67-Mwt tests, operation was on two coolant loops; whereas, during the 20 Mwt test, operation was on three coolant loops. At 67 Mwt, significant thermal transients of the nature of random fluctuations were observed in the reactor outlet temperature as measured by the temperature detectors. Thermal fluctuations and transients occurring in scrams at 9.5, 13.3, and 20 Mwt were insignificant, apparently because of the low power levels involved. No significant fluctuations were observed in other system temperatures recorded. Analysis by analog computer to correct for the detector and associated circuit time constants have produced thermal transient data representative of the actual thermal fluctuations measured by the temperature detectors. Results of the 67-megawatt test show that the most severe thermal transient was experienced at the reactor outlet in primary sodium loop No. 1, where a 44°F-per-second transient was recorded over a temperature change of 76°F. In primary sodium loop No. 2, the most severe transient experienced was 20°F per second over a 48°F temperature change. The original design specification for the Fermi reactor stipulates the worst-case temperature transient in the reactor outlet temperature to be 15.8°F per second for a change of 300°F, with a maximum of 500 transients tolerable. Although the temperature rates of change experienced were comparatively high, the total change in temperature in each instance was well below the specification value. Transport lags of the principal plant parameters were read from the scram test data obtained on strip chart recorders. Performance of all interlock and reset circuitry, as well as operation of the reactor control system, was found to be satisfactory. (auth)

24930 (APDA-NTS-16) THERMAL POWER CALIBRATION OF THE ENRICO FERMI REACTOR. Callen, R. C.; Allgeier, H. J. (Atomic Power Development Associates, Inc., Detroit, Mich.). Feb. 1968. 51p. Dep. CFSTI.

Experiments of thermal power calibration of the Enrico Fermi reactor are described. Preliminary experiments are required to examine temperature detector response and determine system dissipative heat losses. Three determinations are made of reactor power at levels between 85 and 100 MW. The technique employed is to determine the power removed by the feedwater-steam system in the form of superheated steam; this is corrected for extraneous power sources to obtain reactor power. Errors resulting from experimental and operational sources are discussed and comparison of results with those of a nuclear calibration is presented. (auth)

24931 (APED-5179) REACTOR PROTECTION SYSTEM: A RELIABILITY ANALYSIS. Jacobs, I. M. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). June 1966. 65p. (68-APE-1).

The Dual Bus Reactor Protection System currently in use on General Electric boiling water reactors is described in detail. Its reliability is compared with several alternate systems from both a theoretical and a practical point of view. A mathematical reliability model of the system is derived, and used to explore the sensitivity of the system to changes in component integrity. The system has several attributes that make it ideally mated to its reactor. Qualitatively, it meets all the performance and safety criteria that are normally applied to a reactor protection system. Quantitatively, the analytical results from the mathematical reliability model tend to indicate that the system is good and in good balance. The Dual Bus Reactor Protection System is adequate for its intended use. (auth)

24932 (BNWL-735) RIBOT: A PHYSICAL MODEL FOR LIGHT-WATER LATTICES CALCULATIONS. Loizzo, Paolo (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Feb. 1968. Contract AT(45-1)-1830. 43p. Dep. CFSTI.

The computer program, RIBOT-5, is a zero dimensional reactor physics code used for calculating criticality and burnup of light-water reactors. The code requires as input, essential extensive reactor parameters (fuel rod radius, water density, etc.). The nuclear constants (intensive parameters) are calculated with a five-group model (2 thermal and 3 fast groups). A fitting procedure, imitated from the classical engineering approach to problem solving, is systematically employed to reduce the computation time of the code. Zero dimension burn-up calculations are made in an automatic way. A summary physical description, a check with the latest set of experiments with PuO_2-UO_2 rods, and a description of the input-output procedures are presented. (auth)

24933 (BNWL-SA-1529) ISOTOPE PRODUCTION PROJECTIONS FOR U. S. NUCLEAR POWER REACTORS. McKee, R. W.; Deonigi, D. E.; Haffner, D. R. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Mar. 27, 1968. Contract AT(45-1)-1830. 33p. (CONF-680308-8). Dep. CFSTI.

From 155th National Meeting of the American Chemical Society, San Francisco, Calif.

Projections through the year 1990 of quantities of various isotopes recoverable from spent fuel to be discharged from U. S. nuclear power reactors are presented. Secondary irradiation of recovered Am and Np to supplement the production of ^{238}Pu and ^{244}Cm is also discussed. (auth)

24934 (CONF-660524) THORIUM FUEL CYCLE. Proceedings of Second International Symposium, Gatlinburg, Tennessee, May 3-6, 1966. AEC Symposium Series 12. (Oak Ridge National Lab., Tenn.). Feb. 1968. Contract W-7405-eng-26. 847p. Dep. CFSTI.

Forty-three papers are presented under the following headings: Thorium Reactor Concepts and Physics, Thorium Fuel-Cycle Economics, Thorium Reactor Fuel Fabrication, Thorium Fuel Preparation and Irradiation Testing, Thorium Fuel Processing Studies and Demonstrations, Thorium-Fueled Reactor Operating Experience, and General. Twenty-seven papers were previously abstracted in NSA. A separate abstract was prepared for each of 16 papers. (D.L.C.)

For abstracts of individual papers see: 23092, 23093, 23190, 23191, 23853–23858, 23904, and 24935–24939.

24935 (CONF-660524-, pp 41-63) SUMMARY OF MOLTEN-SALT BREEDER REACTOR DESIGN STUDIES. Kasten, Paul R.; Bettis, E. S.; Bauman, H. F.; Carter, W. L.; McDonald, W. B.; Robertson, R. C.; Westsik, J. H. (Oak Ridge National Lab., Tenn.).

Design and evaluation studies were made of thermal molten-salt breeder reactors (MSBR) to assess their economic and nuclear potential and to identify important design and development problems. The MSBR reference-design concept is a two-region two-fluid system with fuel salt separated from the blanket salt by graphite tubes. The energy produced in the reactor fluid is transferred to a secondary coolant-salt circuit that couples the reactor to a supercritical steam cycle. On-site fluoride volatility processing is employed, which leads to low unit processing costs and economic reactor operation as a thermal breeder. The resulting power cost is estimated to be 2.7 mills/kW-hr for investor-owned utilities. The associated fuel-cycle cost is 0.45 mill/kW(e)-hr, the specific fissile inventory is 0.8 kg/MW(e), and the fuel doubling time is 21 years. Development of a protactinium removal scheme for the blanket region of the MSBR could lead to power costs of 2.6 mills/kW(e)-hr, a fuel-cycle cost of 0.33 mill/kW(e)-hr, a specific fissile inventory of 0.7 kg/MW(e), and a fuel doubling time of 13 years. (auth)

24936 (CONF-660524-, pp 91-105) THORIUM HIGH TEMPERATURE REACTOR CONCEPT. Schulten, R.; Lueders, J. D. (Kernforschungsanlage, Juelich (West Germany). Brown Boveri/Krupp Reaktorbau G.m.b.H., Duesseldorf (West Germany)).

For the Thorium High Temperature Reactor (THTR) project a prototype of 300 MW(e) is being designed. A survey is presented of the technical concept of the THTR prototype. Major characteristic components of this pebble-bed reactor are discussed in the light of recent research and development work. The results of this work indicate that considerable simplification, as compared to the first pebble-bed reactor, is possible and thus renders an economic realization of the THTR concept attainable in the not-too-distant future. (auth)

24937 (CONF-660524-, pp 119-28) THORIUM AND THE ORGEL CONCEPT. Lafontaine, F.; Noailly, J.; Haytink, B. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center).

An analysis is made of the general characteristics of different 500-MW(e) ORGEL-type reactors burning alternatively natural or slightly enriched uranium and enriched thorium. The principal parameters analyzed are (1) investment in fissile material, (2) investment in heavy water, and (3) specific consumption in fissile material. Although the investment in fissile material of the ORGEL thorium reactor is higher than that of the ORGEL uranium reactor, it can be kept sufficiently low so as not to increase the fuel cycle cost. The economy of the ORGEL thorium concept strongly depends on the reprocessing cost of its fuels, and this is the weak point of the concept. It is a very important drawback in comparison with the ORGEL uranium concept, which is already economically attractive without fuel reprocessing. The ORGEL thorium reactor type is already in a well advanced stage; the research and development work related to the ORGEL thorium concept may thus only be devoted to its fuel cycle technology. (auth)

24938 (CONF-660524-, pp 681-94) COMPARISON OF MEASURED AND PREDICTED CHARACTERISTICS OF THE ELK RIVER REACTOR. Fisher, J. R.; Kendrick, E. D. (Allis-Chalmers Mfg. Co., Bethesda, Md. Atomic Energy Div.).

The Elk River Reactor is a second-round, ThO_2–UO_2 fueled, stainless-steel clad, boiling water reactor built for the Rural Cooperative Power Company. One of the stated objectives of the reactor is the demonstration of the thorium cycle. The final physics design and pre-start-up analysis were done in 1958 to 1962. The reactor was loaded in 1963, reached full power in 1964, and shut down for its first refueling in April 1966. At the time of shutdown, the core had achieved an average burnup of 7040 MWd/metric ton. Agreement between predicted and observed performance was excellent throughout the core life. (auth)

24939 (CONF-660524–, pp 695–715) PROGRESS OF ZERO-POWER EXPERIMENTS IN THE PEACH BOTTOM HIGH-TEMPERATURE GAS-COOLED REACTOR. Van Howe, K. R.; Brown, J. R. (General Dynamics Corp., San Diego, Calif. General Atomic Div.).

The Peach Bottom High-Temperature Gas-Cooled Reactor is a graphite-moderated gas-cooled power reactor that operates with a ^{235}U–^{232}Th–^{233}U fuel cycle. The reactor, owned and operated by the Philadelphia Electric Company, is designed to produce 40 MW(e). By May 1966 it is expected that the reactor will have been fueled and a large number of the zero-power experiments will have been completed. These zero-power experiments, discussed in this paper, include: (1) loading of fuel to achieve initial criticality, (2) power-distribution measurements, (3) control-rod-worth measurements, (4) determination of the cold, clean excess reactivity, and (5) reactivity worth of thorium, uranium, and other core materials. (auth)

24940 (DOCKET-1155–1) LA CROSSE BOILING WATER REACTOR. APPLICATION FOR TRANSFER OF PROVISIONAL OPERATING AUTHORIZATION DPRA-5. (Dairyland Power Cooperative, La Crosse, Wis.). Oct. 4, 1967. 230p. Dep. CFSTI.

The request for transfer of operating authority, DPRA-5, of the La Crosse Boiling Water Reactor (LACBWR) from Allis-Chalmers to Dairyland Power Cooperative is presented. Included as support for the request are: Excerpts from the minutes of the Sept. 15, 1967, meeting of the Board of Directors of Dairyland Power Cooperative; names and business affiliation of Principal Officers and Board of Directors; qualifications of Dairyland Power to operate LACBWR; technical specifications for LACBWR; proposed revisions to the Allis-Chalmers technical specifications; and a list of reference documents filed prior to Jan. 1, 1968, by Allis-Chalmers under Docket No. 115-5 pursuant to provisional operating authority DPRA-5. (M.L.S.)

24941 (DOCKET-1155–2) LA CROSSE BOILING WATER REACTOR. APPLICATION FOR TRANSFER OF PROVISIONAL OPERATING AUTHORIZATION DPRA-5. Amendment 1, Revisions to Exhibit C. (Dairyland Power Cooperative, La Crosse, Wis.). Nov. 22, 1967. 115p. Dep. CFSTI.

A complete description of technical support services for the La Crosse Boiling Water Reactor is given. Organization and scope of work to be performed by the contractor for technical support services, United Nuclear Corp., are described. (M.L.S.)

24942 (DOCKET-1155–3) LA CROSSE BOILING WATER REACTOR. APPLICATION FOR TRANSFER OF PROVISIONAL OPERATING AUTHORIZATION DPRA-5. Amendment 2. (Dairyland Power Cooperative, La Crosse, Wis.). Feb. 21, 1968. 6p. Dep. CFSTI.

Additional information on La Crosse Boiling Water Reactor cooling system surveillance, stack inspection and maintenance, and steam generation system leak detection is given. (M.L.S.)

24943 (DOCKET-1155–4) LA CROSSE BOILING WATER REACTOR CONSTRUCTION AUTHORIZATION. HAZARDS ANALYSIS BY THE DIVISION OF LICENSING AND REGULATION. (Allis-Chalmers Mfg. Co., [Milwaukee, Wis.] Dairyland Power Cooperative, La Crosse, Wis.). Jan. 4, 1963. 30p. Dep. CFSTI.

A complete safety analysis of the La Crosse Boiling Water Reactor, performed by the Division of Licensing and Regulation of the AEC, is given. (M.L.S.)

24944 (DOCKET-50244–3) ROBERT EMMETT GINNA NUCLEAR POWER PLANT, UNIT NO. 1. Final Facility Description and Safety Analysis Report, Suppl. 1, Exhibit D–6. (Rochester Gas and Electric Corp., N. Y.). Mar. 29, 1968. 60p. Dep. CFSTI.

Revised information on Robert E. Ginna Power Reactor, Unit 1, is given. Information is included on: reactor design, steam generator design, reactor trip circuits, principal component data summary, steam and power conversion systems, and shielding and radiation monitoring. (M.L.S.)

24945 (DOCKET-50272–7) SALEM NUCLEAR GENERATING STATION. [Preliminary Facility Description and Safety Analysis Report], Amendment 6. (Public Service Electric and Gas Co., Newark, N. J.). Apr. 15, 1968. 245p. (DOCKET-50311–7). Dep. CFSTI.

Additional information on design water levels for the Salem Power Reactor is given; plant water intake and discharge is described. Core heat up during a loss of coolant accident is summarized; structural heat sinks are tabulated. Radiological consequences of Emergency Core Cooling System (ECCS) piping breaks are evaluated; design and function of engineered safeguards systems are discussed. Electrical penetrations and cable run designs are evaluated. Emergency plans are detailed. Soil foundation and soil preparation are described; a report on liquefaction studies is included. Effects of seismic loadings on containment structures and systems are analyzed. Containment structure design criteria and analyses are detailed; liner design is given; penetration design data are tabulated. Construction procedures are described. Effects of failure of rotating parts of the turbine-generator are analyzed. (M.L.S.)

24946 (DOCKET-50282–6) [PRAIRIE ISLAND NUCLEAR GENERATING PLANT, RED WING, MINNESOTA, UNITS 1 AND 2]. [Facility Description and Safety Analysis Report], Amendment 2. (Northern States Power Co., Minneapolis, Minn.). Dec. 15, 1967. 275p. (DOCKET-50306–6). Dep. CFSTI.

Additional or revised information is given on Prairie Island, Prairie Island Power Reactor, Units 1 and 2. In addition, information is included under the following broad subjects: Seismic Design–soil compaction, foundation details, differential building motion during an earthquake, design criteria for simultaneous earthquake and maximum hypothetical accident, shield building integrity during an earthquake, model used for seismic analysis of reactor building, criteria for buildings of both Class I and Class II classification, and allowed deformation for no loss of function; Seismology; Containment–design basis, testing of engineered safeguards, penetration design and criteria, charcoal filters, containment leak testing, missile protection, and steam line failure in the annulus; Nuclear Steam Supply Associated Engineered Safeguards; Site Meteorology and Waste Releases; Emergency Power; Service Water Design; Proposed 70 Criteria; Startup Committees; Emergency Plans; Reliability of Cooling Water Supply; Construction Quality Assurance; and Corrosion Protection. (M.L.S.)

24947 (DOCKET-50282–7) PRAIRIE ISLAND NUCLEAR GENERATING PLANT, RED WING, MINNESOTA, UNITS 1 AND 2. Facility Description and Safety Analysis Report, Amendment 3. (Northern States Power Co., Minneapolis, Minn.). Jan. 12, 1968. 95p. (DOCKET-50306–7). Dep. CFSTI.

Additional information on the plant instrumentation and control systems for Prairie Island Power Reactor, Units 1 and 2, is given. Design information on containment penetrations, missile protection, external pressure loading, leakage, and bases for containment design is detailed. Seismicity analysis procedures are discussed. (M.L.S.)

24948 (DOCKET-50282–8) PRAIRIE ISLAND NUCLEAR GENERATING PLANT, RED WING, MINNESOTA, UNITS 1 AND 2. Facility Description and Safety Analysis Report, Vol. 4. (Northern States Power Co., Minneapolis, Minn.). Dec. 18, 1967. 175p. (DOCKET-50306–8). Dep. CFSTI.

Additional design and operation information on Prairie Island Power Reactor, Units 1 and 2, is presented. Information pertains to: special design procedures; containment capability analysis; overall plant requirements; power escalation test program; and effect of variation of shield building vent system parameters. (M.L.S.)

24949 (DOCKET-50298–8) COOPER NUCLEAR STATION. Safety Evaluation. (Consumers Public Power District, Columbus, Nebr.). Apr. 4, 1968. 73p. Dep. CFSTI.

An AEC–DRL safety evaluation of the Cooper Power Reactor is presented. Principal plant features are discussed; safety features are evaluated. Accident analyses are discussed; areas where further technical information is needed are discussed. Appendices contain: ACRS report; chronology–Regulatory Review; U. S. Weather Bureau report; U. S. Geological Survey; U. S. Coast and Geodetic Survey; Dr. N. M. Newmark's evaluation of station structural criteria; and U. S. Fish and Wildlife Service report. (M.L.S.)

24950 (DOCKET-50301–3) POINT BEACH NUCLEAR PLANT, UNIT NO. 2. [Preliminary Facility Description and Safety Analysis Report, Amendment 5, Suppl. 3. (Wisconsin Electric Power Co., Milwaukee. Wisconsin Michigan Power Co., Appleton, Wis.). Apr. 9, 1968. 29p. Dep. CFSTI.

Stress deformation calculation techniques for the containment structure liner for Point Beach Power Reactor, Unit 2, are out-

lined. The experimental program for core-spray additive development is detailed. The quality control program in effect during construction is described. Shutdown margin and reactivity control are discussed. (M.L.S.)

24951 (DOCKET-50315-1) DONALD C. COOK NUCLEAR PLANT. APPLICATION FOR CONSTRUCTION PERMIT AND OPERATING LICENSE. Amendment 1. (Indiana and Michigan Electric Co., Fort Wayne, Ind.). Apr. 1, 1968. 225p. (DOCKET-50316-1). Dep. CFSTI.

A description of the turbine unit for the Donald C. Cook Power Reactor, Unit 2, is given; an analysis of probability and consequences of turbine failure for both power reactor Units 1 and 2 of the power station is detailed. The mathematical model to be used for seismic analysis of the containment structures is given. The results of on-site foundation investigations are presented. Financial reports for 1967 for the Indiana and Michigan Electric Company and the American Electric Company, Inc., are included. (M.L.S.)

24952 (DUN-SA-62) CHEMICAL DECONTAMINATION OF LARGE NUCLEAR STEAM GENERATORS: A CASE HISTORY. Bainard, W. D.; Kratzer, W. K.; Larrick, A. P. (Douglas United Nuclear, Inc., Richland, Wash.). Feb. 28, 1968. Contract AT-(45-1)-1857. 20p. (CONF-680313-1). Dep. CFSTI.

From 24th Annual National Association of Corrosion Engineers Conference, Cleveland, Ohio.

The chemical decontamination process of the NPR is described. A description of the reactor system is presented. Effects of corrosion and analysis of corrosion measurements are presented. (D.C.C.)

24953 (EUR-3561) THE DEVELOPMENT OF LIGHT WATER REACTORS IN THE COMMUNITY. Proceedings of the Meeting Organized by Euratom, Brussels, November 23-24, 1966. (European Atomic Energy Community). Oct. 1967. 569p. (In Several Languages). (CONF-661134). Euratom $12.00.

Separate abstracts are prepared for 22 of the 23 papers included. Information on the development and economic aspects of water-cooled power reactors in the EURATOM community is presented. (M.L.S.)

For abstracts of individual papers see: 23722, 24999-25018, and 25147.

24954 (EUR-3888) KERNKRAFTWERK GUNDREMMINGEN (KRB). Jahresbericht, 1966. (Gundremmingen (KRB) Nuclear Power Plant. Annual Report, 1966). (Kernkraftwerk RWE-Bayernwerk G.m.b.H., Gundremmingen (West Germany)). 1968. 70p. (In German). Dep.

A brief history of the Gundremmingen Power Reactor is given. A timetable for systems checkouts is shown. Low-power preoperational tests are described in detail; data are given. Layouts of all systems are shown. Construction and assembly timetables are given; construction costs are tabulated. (M.L.S.)

24955 (EUR-3891) MESSA A PUNTO DI UN METODO PER IL CALCOLO DI NOCCIOLI ARRICCHITI IN PLUTONIO AI FINI DEL RICICLO DEL PLUTONIO NEI REATTORI TERMICI. Relazione Finale. (Development of a Method for Calculating Plutonium-Enriched Cores for the Purpose of Plutonium Recycling in Thermal Reactors. Final Report). Corona, R.; Ghilardotti, G.; Imperato, G.; (and others) (Societa Nazionale Metanodotti, Milan (Italy). Laboratori Reuniti Studi e Ricerche). Dec. 4, 1967. 267p. (In Italian). Dep.

Calculational methods applied to group parameters for plutonium recycle reactors are discussed. Experience gained in recycle calculations at Hanford and Saxton is outlined. Comparisons of values obtained from GAM-THERMOS and LASER codes are made. Use of the P_1 and B_1 approximations is discussed. Results of calculations for cross sections, multiplication factors, diffusion coefficients, and Doppler coefficients are tabulated. The iterative procedures of the THERMOS code are described; methods for quick calculations are outlined. A complete listing of the PROKAIMING computer program for diffusion coefficient calculations is given (in Italian). A description of five additional codes for calculation of reactor parameters is given. 29 references. (M.L.S.)

24956 (EURAEC-1997) RESEARCH PROGRAM ON THE HEAT TRANSFER AND FLUID FLOW CHARACTERISTICS OF A PRESSURIZED WATER REACTOR. Final Report. (Technische Hogeschool, Eindhoven (Netherlands)). Dec. 1967. Contract 011-69-1-TEEN(RD). 59p. (EUR-3790; WW-015-R128). Dep. CFSTI.

Work Performed under United States-Euratom Joint Research and Development Program.

A description of the 140 atmospheres pressurized water loop is presented. A review of the activities of the instrument development undertaken is also presented. A description of a mathematical model to analyze the flow process in the multirod fuel assembly incorporating the transverse transport of fluid coming from diffusion and radial pressure differences is included. (auth)

24957 (GA-7698) DESIGN OF COATED PARTICLE FUEL FOR HIGH-TEMPERATURE GAS-COOLED REACTORS. Goeddel, W. V.; Scott, J. L. (Gulf General Atomic, Inc., San Diego, Calif.). Jan. 30, 1967. Contract AT(04-3)-167. 7p. Dep. CFSTI.

A review of design and performance criteria for pyrolytic carbon-coated fuel particles is presented. Diagrams and cross-sectioned views of various types are also presented. (D.C.C.)

24958 (GAMD-5109) ON THE CHOICE OF A MOISTURE DETECTOR FOR HTGR COOLANT LOOPS. Roes, J. B. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). July 28, 1964. Contract AT(04-3)-617. 31p. Dep. CFSTI.

For the safe and economical operation of HTGR-type reactors, continuous monitoring of the moisture content of the coolant gas is required. The requirements of the moisture detection system are such that no readily available instrument can be used. An attempt has been made to determine which moisture detection scheme holds the most promise for adaptation to the requirements of the HTGR control system. A number of schemes have been tested. A recommendation is made that a suitable optical dewpoint detector be developed. (auth)

24959 (GAMD-7910) XENON POISONING DURING RISE TO POWER IN PEACH BOTTOM. Results of Post Construction R and D Test Procedures DP-8, GP-1, and GP-3. Brown, J. R.; Van Howe, K. R. (Gulf General Atomic, Inc., San Diego, Calif.). Jan. 22, 1968. Contract AT(04-3)-314. 21p. Dep. CFSTI.

In performing a Xe buildup or Xe decay test, the reactor power level is rapidly (<3 hours) changed from a near equilibrium ^{135}Xe and temperature condition to a new set of conditions. These new reactor conditions are held constant for 48 to 72 hours. As the Xe decays or builds up, the control rod positions required to maintain criticality are recorded. From the control rod calibration curves, the reactivity changes with time are determined. The calculation of the changes in the reactivity effect of ^{135}Xe on the core reactivity is made using the computer code GARP. Results are presented. (auth)

24960 (GAMD-7911) CORE HEAT TRANSFER MEASUREMENTS DURING RISE TO POWER IN PEACH BOTTOM. (Results of Post Construction R and D Procedures DO-5 and GO-4). Lane, R. K.; Petersen, J. F. (Gulf General Atomic, Inc., San Diego, Calif.). Feb. 1, 1968. Contract AT(04-3)-314. 26p. Dep. CFSTI.

Results are presented of two tests performed during the rise-to-power program to measure the heat transfer film coefficient as a function of helium flow through the Peach Bottom reactor core. Test DO-5 was performed for flow variations up to 35% nominal full flow, and GO-4 was conducted to determine the heat transfer film coefficient variation over the range of 40 to 100% of nominal full helium flow. (H.D.R.)

24961 (GEAP-5411) TURBULENT VELOCITY DISTRIBUTION IN A ROD BUNDLE. Bender, D. J.; Switick, D. M.; Field, J. H. (General Electric Co., Sunnyvale, Calif. Advanced Products Operation). Oct. 1967. Contract AT(04-3)-189. 35p. Dep. CFSTI.

A method to determine the two-dimensional velocity distribution for turbulent, constant property single-phase flow through an infinite triangular rod bundle is presented. Turbulent momentum transport is directly calculated via a mixing length theory based on actual flow geometry. The velocity solution vector is determined by iteration between the momentum equation and the definition of turbulent momentum diffusivity. Correlation of the results shows the method to be consistent with experimental data and preferable to other analytic methods investigated. However, more detailed experimental data are necessary to demonstrate the general validity of the method. VELVET, a digital computer code to perform the required calculations, has been programmed for the General Electric 635 Data Processing System. (auth)

24962 (HMI-B-68) CHEMISCHE ASPEKTE DER REAKTORSICHERHEIT (LITERATURUEBERSICHT). 2. Halbjahresbericht im Auftrag des Bundesministeriums fuer Wissenschaftliche Forschung. (Chemical Aspects of Reactor Safety (Literature Review). Second Semiannual Report by Order of the Ministry for Scientific Research). Hoinkis, E. (Hahn-Meitner-Institut fuer Kernforschung, Berlin (West Germany)). Mar. 1968. 54p. (In German). Dep.

The chemical aspects of reactor safety are described generally.

These include: the release and transport of fission products from uranium dioxide (UO_2) and coated particle fuels; adsorption, release, and transport of fission product iodine and iodine compounds; containment filtration systems; metal–water reactions; oxidation of graphite and coated particles by steam; corrosion; reaction of fuel materials with water and steam; and chemical problems in the use of sodium coolants. 128 references. (M.L.S.)

24963 (IBK-241) METODE I PROGRAMI ZA FIZICKI PRORACUN ENERGETSKIH TESKOVODNIH REAKTORA. (Physical Calculations for Heavy Water Power Reactors: Methods and Programmes). Pop-Jordanov, J.; Bosevski, T.; Matausek, M.; Stojadinovic, A.; Jovanovic, S.; Zivkovic, Z.; Slipicevic, K. (Institut za Nuklearne Nauke Boris Kidric, Belgrade (Yugoslavia)). May 1965. 114p. (In Yugoslavian). DTIE.

Definitions, equations and computer programs are given to facilitate the physical calculations of heavy-water power reactors with fuel element bundles, operating with either boiling or non-boiling coolant. The reactor parameters are calculated as a function of the moderator temperature, void content and burnup, taking poisoning effect into account. The data allow dimensional values and flux distribution curves for a three-region reactor to be derived. The computer program in machine language is also included with the flow diagram. The results are presented in tabular and graphic form. (TTT)

24964 (IDO-17249) EXPERIMENTAL EVALUATION OR EMERGENCY CORE SPRAY COOLING PERFORMANCE. Jensen, R. T. (Phillips Petroleum Co., Idaho Falls, Idaho. Atomic Energy Div.). Mar. 1968. Contract AT(10-1)-205. 39p. Dep. CFSTI.

A study was performed to determine the heat transfer mechanisms associated with the use of core spray systems. A nine-rod array of electrically heated rods was enclosed in a glass cylinder. The rods were allowed to heat until the surfaces reached predetermined temperatures between 500 and 1500°F. The rods were then sprayed with cold water and the resulting phenomena observed. Because the rod surfaces were at temperatures above the Leidenfrost Point, the water was ejected from the surface and thrown out to the inside wall of the cylinder. A water film eventually formed near the top of the rods with "sputtering" occurring at the leading edge of the film; the lower portion of the rods remained dry until the film progressed down the full length of the rods. The heat transfer mechanism was found to be radiation from rod to rod, radiation to the water film on the cylinder wall, and natural convection to the steam in the cylinder when the rod surface temperatures were above 1250°F. At rod surface temperatures below 1250°F, an additional heat transfer mechanism, which cannot be readily defined at this time, accounts for as much as 65 percent of the total heat transfer. (auth)

24965 (IS-1808) NEUTRON KINETICS OF HEAVY WATER MODERATED REACTORS. Crudele, Joseph Samuel (Ames Lab., Iowa). Feb. 1968. Contract W-7405-eng-82. 82p. Dep. CFSTI.

The integral solution form of the reactor kinetic equations developed by Keepin and Cox was used to obtain neutron responses to ramp and step changes of reactivity in U-235 fueled, D_2O moderated reactors. The errors introduced by the size of the time interval used in the Simpson rule approximation to this solution were studied. Comparisons were made for the effects of using fast fission delayed neutrons and thermal fission delayed neutrons. Results were also obtained for the effects caused by changes in the number of delayed neutron groups used, the gamma ray transmission, the total effective delayed neutron fraction and the prompt neutron lifetime. The characteristic parameters Sj, Aj and Bj were generated for neutron lifetimes from 10^{-4} to 10^{-3} seconds using 14 delayed neutron groups, a gamma ray transmission of 70 percent and a total effective delayed neutron fraction of 0.0075. (auth)

24966 (KFK-650) THE BALANCED OSCILLATOR TESTS IN SEFOR. Caldarola, L.; Giordano, P.; Audoux, M.; Rohrbacher, H.; Russell, C. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Angewandte Reaktorphysik). Aug. 1967. 51p. (EUR-3686). Dep.

In SEFOR, Balanced Oscillator Tests will be performed to measure reactivity coefficients. Two types of Balanced Oscillator Tests are planned for SEFOR: the First Balanced Oscillator Test (1st B.O.T.) in which, while the coolant temperature is kept constant, the transfer functions between reactivity and power and between power and coolant flow are measured. The second Balanced Oscillator Test (2nd B.O.T.) in which, while the reactor power is kept constant, the transfer function between reactivity and coolant temperature is measured. Particular effort has been devoted to studying possible ways of obtaining balancing conditions in the reactor plant. Two different types of control are being considered: (1) Open Loop Control in which predetermined input signals will be given to the reactor plant in order to hold constant the coolant temperature (for the 1st B.O.T.) and the power (for the 2nd B.O.T.). (2) Closed Loop Control in which the balance condition (constancy of the coolant temperature for the 1st B.O.T. and power for the 2nd B.O.T.) is reached with the aid of closed loops control. Both control methods are described and their performance characteristics are also analyzed. (auth)

24967 (LA-DC-9423) DYNAMIC CHARACTERISTICS OF A SODIUM OXIDE PLUGGING INDICATOR. McPheeters, Charles C.; Biery, John C. (Los Alamos Scientific Lab., N. Mex.). [1968]. Contract W-7405-eng-36. 4p. (CONF-680601-9). Dep. CFSTI.

From 14th Annual Meeting of the American Nuclear Society, Toronto, Ontario.

The application of a Na_2O plugging indicator as an analytical instrument for indicating O_2 concentrations in liquid Na is presented. The plugging meter was calibrated, and the plugging temperature was correlated with flow rate, cooling rate, and O_2 concentration. (D.C.C.)

24968 (LA-DC-9424) CRITICAL EXPERIMENTS IN UHTREX. Carmichael, B. M. (Los Alamos Scientific Lab., N. Mex.). [1967]. Contract W-7405-eng-36. 3p. (CONF-680601-3). Dep. CFSTI.

From 14th Annual Meeting of the American Nuclear Society, Toronto, Ontario.

A description of the UHTREX facility is presented. Physics measurements for critical operation are presented. (D.C.C.)

24969 (LA-DC-9426) GEOMETRIC PROBLEMS AND CALCULATIONAL METHODS ASSOCIATED WITH A RADIALLY LOADED REACTOR. LaBauve, R. J.; Vigil, J. C. (Los Alamos Scientific Lab., N. Mex.). [1967]. Contract W-7405-eng-36. 4p. (CONF-680601-6). Dep. CFSTI.

From 14th Annual Meeting of the American Nuclear Society, Toronto, Ontario.

The calculation of the thermalization and heterogeneity effects in the UHTREX reactor core is described. Cell calculations were run in one- and two-dimensional representative geometries for each radial position, each cell consisting of the fuel element with an average volume of surrounding moderator. The thermal spectral range was considered to extend from zero to 3 eV. The thermal flux profile for a fuel element is presented. (D.C.C.)

24970 (NAA-SR-Memo-12268) REACTION OF RESIDUAL SODIUM IN HNPF PRIMARY SODIUM SYSTEMS. Boardman, T. J.; Sudar, S. (Atomics International, Canoga Park, Calif.). May 15, 1967. Contract AT(04-3)-701. 43p. Dep. CFSTI.

The activity specification covering reaction of residual Na in the HNPF primary system (HNPF Retirement, Activity Specification 5) requires that residual Na in the primary system be converted to an essentially chemically inactive form. Processes for reacting the residual Na and procedures for reacting and/or removing it, in conformance with the HNPF Retirement Plan, are presented. The recommended reaction procedure and removal procedure for the primary system are outlined in the following steps. (1) Isolate the reactor vessel from the remainder of the primary heat transfer system by removing the block and throttle valves, then capping the Na inlet and outlet lines to the reactor vessel. (2) Remove as much residual Na as possible from the bottom of the reactor vessel, using a pumping system which is specially designed for this purpose. (3) Chemically react the residual Na in the reactor vessel with a mixture of steam and nitrogen which will be circulated through the vessel. (4) Cool the reactor vessel to room temperature while maintaining a low nitrogen flow passing through the reactor vessel. (5) Seal the reactor vessel. (6) Remove and/or react residual Na in other primary system components as necessary, depending on which of the alternate procedures is selected for disposal of the particular component. An experimental program will be carried out to verify reaction characteristics of the proposed steam-nitrogen reaction procedure. (auth)

24971 (NYO-3304-11) INVESTIGATION OF BOILING FLOW REGIMES AND CRITICAL HEAT FLUX. Quarterly Progress Report, March 16, 1967–September 15, 1967. Bergles, A. E.; Roos, J. P.; Abraham, S. C.; Gouda, S. C.; Maulbetsch, J. S. (Dynatech Corp., Cambridge, Mass.). Jan. 1968. Contract AT(30-1)-3304. 67p. Dep. CFSTI.

Film thickness and critical heat flux data for 0.4 in. tubes were taken. The critical condition for $G \cong 0.2 \times 10^6$ and 0.4×10^6 lbm/hr-ft^2 occurs at approximately constant quality for a wide range of inlet conditions. Film persistence and abnormally high critical heat fluxes are observed at inlet qualities greater than about 50

percent. More detailed observations of acoustic instabilities are presented. In the subcooled region the inlet pressure fluctuations can be a significant percentage of the pressure level, and pressure drop oscillations are far in excess of the steady-state pressure drop. Using the results of a previous analysis, calculations are made for frequency and threshold of oscillations. The analytical predictions are in reasonable agreement with the observed frequency level and the variation of frequency level with exit quality. The oscillation threshold corresponds to the negative-sloping portion of the steady-state pressure drop-velocity curve as predicted by the analysis. Flow regime, critical heat flux, and film observations are presented for an 0.8-in. diameter tube. A comparison with earlier results indicates that flow regime boundaries shift to lower quality as tube diameter is increased. By varying inlet quality it is possible to determine the effect of heat flux on flow regime boundaries. Nucleate boiling agitation promotes slug flow at lower mass velocities, but breaks up slug flow at higher mass velocities. Film flow rate behavior is similar to that observed with smaller diameter tubes; however, the critical heat flux is decreased as diameter is increased. An examination of local pressure drop components indicates that flow regime transitions for diabatic flow cannot be defined on the basis of dominant physical forces. A possible method of empirical correlation is discussed. Film measurements are compared with several semi-empirical predictions. The adiabatic film thicknesses are considerably higher than those predicted by the Levy equation, and at low quality, even higher than the Martinelli–Nelson predictions. Electric probe traces and photographs of adiabatic air-water flow indicate that the discrepancy is due in large part to entrained vapor within the liquid film. Design details of the electrically heated four-rod bundle test section are presented. Visual studies were carried out in an air-water loop to determine the most satisfactory geometrical configuration for the introduction of the steam-water mixture at the inlet of the bundle assembly. (auth)

24972 (ORNL–3745) PERFORMANCE OF EXPERIMENTAL JET PUMPS UNDER NONCAVITATING AND CAVITATING CONDITIONS. Lackey, M. E.; Holcomb, R. S.; Lynch, F. E. (Oak Ridge National Lab., Tenn.). May 1966. Contract W-7405-eng-26. 45p. Dep. CFSTI.

A jet pump with a nozzle-to-throat area ratio of 0.035 was operated in water with several nozzle-stream flows in order to study performance and to observe the effects associated with a change in nozzle-stream flow. The test pump had a nozzle diameter of 0.1324 in. and a throat diameter of 0.710 in. The spacing between the nozzle and the throat was varied between 0.0625 and 1.65 in. Two throat length-to-diameter ratios, 4 and 2, and two diffuser angles, 4° and 5°, were tested. The results were interpreted in terms of the overall pump performance and as the limitation imposed on the sidestream flow by the static and thermal suppression heads at the throat inlet. In addition to indicating performance, the side-stream flow limitation indicates the type of flow pattern a succeeding jet pump or centrifugal pump will have to accept over a range of operating conditions. To supplement the measured performance results, photographs were taken of the flow at various operating conditions. For noncavitating operation, changes in nozzle-stream flow did not measurably affect the characteristic curve of head versus flow. Under cavitating conditions, both the head and flow characteristics changed as the nozzle-stream flow was varied. (auth)

24973 (ORNL–TM–2157) INFLUENCE OF NEUTRON DATA IN THE DESIGN OF OTHER TYPES OF POWER REACTORS. Perry, A. M. (Oak Ridge National Lab., Tenn.). Mar. 8, 1968. Contract W-7405-eng-26. 24p. (CONF-680307-26). Dep. CFSTI.

From 2nd Conference on Neutron Cross Sections and Technology, Washington, D. C.

The effects of cross-section uncertainties on estimates of breeding performance and of power cost for a molten-salt reactor are shown to be small. Uncertainty in breeding ratio due to cross-section uncertainties is less than ±0.02, and the uncertainty in power costs is less than ±0.03 mills/kwhr(e). Similarly small effects are shown for the high-temperature gas-cooled reactor. The need for further refinements in nuclear data is related primarily to the calculation of temperature coefficients of reactivity. (auth)

24974 (PRWRA–120) CONTAINMENT BUILDING LEAK TEST. Velez, Gilberto A. (Puerto Rico Water Resources Authority, San Juan). Nov. 1967. 47p. (WRA-B-67-21). Dep. CFSTI.

The equipment, procedures, and results of the BONUS reactor containment leak rate test are presented. A fourteen-day test of the leak tightness of a reference vessel showed a leak rate of 0.0145 building volume per day. An evaluation of the containment building leak test data showed a leak rate of 0.1878 building volume per day, which is within the limits specified by the Technical Specifications for the plant. (H.D.R.)

24975 (TID–24368) ARDENNES NUCLEAR POWER STATION (SENA). Quarterly Report No. 22, October 1–December 31, 1967. (Societe d'Energie Nucleaire Franco-Belge des Ardennes, Chooz-lez-Givet (France)). Jan. 19, 1968. 24p. Dep. CFSTI.

Description of operations includes: operation time schedule; design studies and construction work; personnel; operating results; and expenditures. (D.C.C.)

24976 (WASH–1084) FORECAST OF GROWTH OF NUCLEAR POWER. (Division of Operations Analysis and Forecasting (AEC), Washington, D. C.). Dec. 1967. 51p. Dep. GPO $0.35.

A description of present and forecasted future nuclear power plants utilizing enriched uranium fuel from the United States is presented. Expected power facility growth to 1973 is reported, and forecasted growth to 1980 is presented. Fuel economics and efficiency are discussed. (D.C.C.)

24977 (WCAP–3850–2) POST-IRRADIATION EXAMINATION OF CVTR FUEL ASSEMBLIES. Quarterly Progress Report for the Period Ending December 31, 1967. Balfour, M. G. (ed.) (Westinghouse Electric Corp., Pittsburgh, Pa. Atomic Power Div.). Mar. 1968. Contract AT(30-1)-3850. 64p. Dep. CFSTI.

The results presented were derived from data from nondestructive examinations, destructive examinations, and metallurgical evaluation and fuel failure analysis. Waste disposal and material accountability are discussed. (D.C.C.)

24978 (WCAP–6087) ANALYSES OF THE FISSION GASES RELEASED WITHIN SPENT YANKEE FUEL RODS. Bezella, W. A. (Westinghouse Electric Corp., Pittsburgh, Pa. Atomic Power Div.). Feb. 1968. Contract AT(30-1)-3017. 90p. Dep. CFSTI.

An analysis was conducted of the gases found within 32 UO_2 fuel rods removed from the Yankee reactor. These rods selected for gas analysis experienced average fuel burnups from 3000 MWD/MTU up to 36,000 MWD/MTU. Irradiation was at rather low fuel heat ratings which ranged from 0.94 kw/ft to 4.1 kw/ft with fuel average pellet temperatures during irradiation estimated to range from 785°F to 1450°F. The composition of the total gas collected from the fuel rods was determined spectrographically with the amount of the gas constituents evaluated volumetrically. The evolved fission gases (Kr and Xe) found within the fuel rods varied between 0.05 percent and 8.5 percent of the amount which was theoretically produced. Helium gas found within the fuel rods ranged from 1.5 percent to approximately 100 percent of that generated and was attributed to ternary fissions. An attempt to correlate the helium and the fission gas (Kr and Xe) release data from 20 of these fuel rods using a modified diffusion model met with limited success. The rather low temperature experienced by the UO_2 fuel, the relatively large amounts of H_2 and He gas present within the fuel rods, the uncertainties associated with the prediction of fuel rod thermal histories, and the basic diffusion model itself precluded the establishment of a unique set of correlating diffusion parameters. (auth)

24979 (ORNL-tr-1855) CONCEPT OF THE "SAWA" AND "WARS" BOILING SALT REACTORS. Taube, M.; Kowalew, A.; Poturaj-Gutniak, S.; Mielcarski, M. Translated from Kernenergie, 10: 184-6(1967). 7p. Dep. CFSTI. JCL $1.10 fs, $0.80 mf.

Boiling reactors using salts as nuclear fuel and with direct cooling may have a special role in the development of future nuclear power. A concept for two such reactors is presented. Their characteristics and some of their properties are compared mutually as well as with fast reactors utilizing non-boiling molten salts as fuel. (auth)

24980 NUCLEAR FISSION ACQUIRES THE RIGHT TO BE CITED AMONG THE ECONOMICAL SOURCES OF PRODUCTION OF ELECTRIC ENERGY. Hubert, E. H. RUM, Rev. Universelle Mines, 110: 225-33(Sept. 1967). (In French).

A review of the history of nuclear energy is given, and the development of power stations using nuclear reactions is outlined, with the simpler functions described in detail. General technological problems, involving construction, fuel choice, pile arrangements, and other areas are outlined. The economic factors bearing on such power plants are noted. A report on the present state and future perspectives in the production of nuclear power is made; values of total power from nuclear units for the United States (13,046 MWe, 1966) and the European Atomic Energy Community (900 MWe, 1965; 4000 MWe, 1970; 40,000 MWe, 1980; fraction of total power produced: 1965, 1%; 1970, 4.9%; 1980, 26%; about 70%

in 2000) are compared. Fast reactors will be used in long-range planning. There is increasing interest in the use of nuclear reactors in desalinization and for the industrial production of heat at moderate temperatures. (BBB)

24981 NUCLEAR RESEARCH AND TECHNOLOGY. Pose, Horst. Chem. Ztg., 91: 929-34(Dec. 5, 1967). (In German).

A review of recent developments is given, particularly of progress announced at the Ausstellung fuer Chemisches Apparatewesen. A review of progress in the second German atomic program is made, particularly in the design of thermal reactors. German industry can now supply 600-MW turnkey units. Development will center on breeders, the second stage nuclear plant. High temperature Th reactors, which are being developed in Juelich, are considered highly promising in Germany as well as in other countries. The development of thermal breeders will permit the exploitation of the large Th reserves available. Nuclear reactor programs are reviewed, with special attention to the plants at Kahl, Gundremmingen, and Grosswelzheim. Models included those by AEG Telefunken (boiling water, superheater), MAN Machinenfabrik Augsburg-Nuernberg AG/Gutehoffnungshuette, Sterkrade AG and AEG (steam-cooled fast breeder), Brown Bovery and Cie AG/Krupp Reaktorbau GmbH (gas-cooled high-temperature), Atomic Power Construction Ltd./Nukleardienst GmbH (AGR). Reactor accessories include new heat-exchanger devices and coolant circulators, as well as pressure regulators. Recent advances in nuclear fuels, laboratory apparatus, analytical techniques, and irradiation units displayed by several European and American firms are described. (BBB)

24982 STUDIES OF PHYSICAL CHARACTERISTICS AND UTILIZATION OF FUEL USED IN EDF GRAPHITE GAS NATURAL URANIUM REACTORS. Noc, Bernard; Israel, Mathieu. Energ. Nucl. (Paris), 10: 8-15(Jan.-Feb. 1968). (In French).

The operation at the maximum power authorized by safety conditions and the corresponding optimum fuel cycle are important factors in the economics of the graphic gas natural U reactors. The problems of physics and strategy of fuel renewal are analyzed. For each point, the actual state of knowledge and the program of experimental and theoric studies already accomplished, or in development, are presented, together with the usual methods used. It is shown that the methods presented can assure an economic run of the reactors in operation. (auth)

24983 IMPROVEMENT IN CONDENSATE TREATMENT OF NUCLEAR STATIONS. Treille, Pierre. Energ. Nucl. (Paris), 10: 2-7(Jan.-Feb. 1968). (In French).

The condensate treatment contributes to the good operation and security of nuclear power stations equipped with gas cooled or boiling water reactors. The first realizations have used ion exchanger mixed-beds with external regeneration. This technique has sometimes rather limited performances and must be improved. The adoption of an external regeneration by Asahi-Degrémont continuous process, leads to an operation more adaptable and more economical while eliminating all the problems resulting from the increase of the unit powers. (auth)

24984 EVOLUTION AND FUTURE PROSPECTS OF NUCLEAR GENERATING PLANT. Angelini, A. M. Elettrotecnica, 54: 332-57(May 1967). (In Italian).

A brief history of the development of the world nuclear power industry is given. Forecasts of installed power for the 1970–1985 period are tabulated according to country. Nuclear power plants, constructed or planned as of 1966, are listed separately for the USA and Britain; a composite list is given for the rest of the world. The various types of reactors are discussed; their application to power production is evaluated. Uranium needs are compared with known resources. 10 references. (M.L.S.)

24985 PRESSURIZED WATER REACTORS. Farbman, G. H.; McGrath, R. G. Elettrotecnica, 54: 367-76(May 1967). (In Italian).

Developments in the technology of pressurized water power reactors are reviewed. The basic nuclear and thermal characteristics of PWR's are discussed, and the fuel elements, control systems, cooling system, and safety features are described. The PWR's operating or under construction in the United States and Europe are tabulated, and some operating experience with the Yankee reactor is reviewed. The outlook for future developments in PWR technology is discussed. (H.D.R.)

24986 DETERMINATION OF THE VOLUMETRICAL FRACTION OF THE STEAM IN EBULLITION OF VOLUME BY MEANS OF APPLICATION OF THE CAPACITIVE METHOD. Canti, G. F.; Chiesa, C.; Cimorelli, L.; Evangelisti, R. (Comitato Nazionale per l' Energia Nucleare, Rome). Calore, 38: 166-75(Apr. 1967). (In Italian).

The application of the impedance method, developed as capacitive, to the study of the bulk boiling at atmospheric pressure is described. Corresponding to two values of mass flowrate, the calibration curves void fraction vs. relative capacitance are deduced, up to void fractions of about 85–90%; as a void fraction standard value the response of the dilatometric method is chosen. The differences between the experimental calibration curves and the Maxwell law are calculated and plotted. 16 references. (auth)

24987 TRANSIENT TEMPERATURE DISTRIBUTION IN PLANE FUEL ELEMENTS. Altieri, P. (Facolta di Ingegneria, Pisa, Italy). Termotecnica (Milan), 21: 269-73(May 1967). (In Italian).

Equations for the description of temperature perturbations in fuel elements are developed. The Laplace transform is applied to the one-dimensional heat balance equation to determine a general solution for temperature as a function of time and space. The analog of this expression gives a time-dependent reactor coolant temperature equation. (M.L.S.)

24988 EJECTING SODIUM FROM REACTOR COOLANT CHANNELS. Schlechtendahl, E. G. (Kernforschungszentrum, Karlsruhe, Ger.). Nukleonik, 10: 270-4(Nov. 1967). (In German).

The phenomenological model for reactor coolant Na boiling and ejection is described. Equations used for the coolant expulsion, heat transfer, and vaporization are given. Time constants for transient vaporization are determined. Bubble formation in the Na coolant is shown as a function of time; fuel temperature- and sodium film-temperature-dependence are shown also. 19 references. (M.L.S.)

24989 TECHNOLOGICAL ASPECTS OF FUSION POWER GENERATION. Carruthers, R. (United Kingdom Atomic Energy Authority, Abingdon, Eng.). J. Fuel Heat. Technol., 15: 17-19(Mar. 1968).

Lecture presented to Institution of Electrical Engineers (London), December 1967, giving an introduction to nuclear fusion as a potential source of power and describing the objectives of studies at the Culham Laboratory. Estimates are made for capital costs and comparative generation costs of fusion power stations. (UK)

24990 REACTOR SUPPLY INDUSTRY. Nucl. News, 11: 36-40(Jan. 1968).

A review of nuclear power plants in operation and under construction in the United States is presented. The review includes: desalting systems; converters–breeders; maritime reactors; military reactors; space systems; and auxiliary power reactors. Types of power reactors are listed as well as plant locations, reactor supplies, estimated cost, and power outputs. (D.C.C.)

24991 OPERATIONAL PROBLEMS AND SOLUTIONS. Skaardal, Rolf C. Reactor Fuel-Process. Technol., 11: 17-26 (Winter 1967–68).

Several cases of reactor system component failures are reviewed. Preparations for repairs, repair procedures, and some equipment modifications are discussed. Mechanical component failures examined are the hydriding of Hanford reactor Zircaloy process tubes, neutron damage to Oak Ridge Research Reactor beryllium and aluminum core components, heat-exchanger tube vibrations in the High Flux Beam Reactor, and circulation-pump seal failure at the Big Rock Point Reactor. Reactor modifications are discussed for a planned replacement of the NRU reactor vessel and the installation and testing of a steel pool liner at the Texas A and M University reactor. 13 references. (H.D.R.)

24992 FURTHER DEVELOPMENTS IN CONTAINMENT-BUILDING ELECTRICAL PENETRATIONS. Verber, Fred. Reactor Fuel-Process. Technol., 11: 5-12(Winter 1967–68).

Containment-building electrical penetration problems and solutions experienced during Fermi and Peach Bottom plant operations are reviewed. Fire-protection modifications to the penetrations and to the electrical design at Peach Bottom following a fire are described. Developments in the design of the Dresden Unit 2 electrical penetration system and assemblies are presented. 6 references. (H.D.R.)

24993 BENEATH THE FORMAL CLOAK. Paxton, Hugh C. Nucl. News, 11: 47-50(Jan. 1968).

A discussion on power reactors-safety operation in terms of hazards evaluation, general experience, and problems encountered is presented. Methods for extracting safety standards and improvements from operation experiences are described. (D.C.C.)

24994 SOME PROBLEMS OF FAST POWER REACTOR DEVELOPMENT. Sulc, Vlastimil; Pasek, Miroslav (Ustav Jaderneho Vyzkumu, Rez, Czechoslovakia). Jad. Energ., 14: 1-10(Jan. 1968). (In Czech).

Results are given on studies of nuclear reactor development and

aspects of further development of fast reactors. Descriptions are given of the most important fast reactors, their fuel and construction materials, and containment liner materials. Problems of the heat transfer system and technological problems are discussed. The construction program for fast nuclear reactors in various countries is also analyzed. (R.V.J.)

24995 CONDITIONS OF CONSTRUCTING NUCLEAR POWER STATIONS IN YUGOSLAVIA IN THE LIGHT OF THEIR DEVELOPMENT THE WORLD ROUND. Salom, Suica. Nukl. Energ., 4: 21-3(1967). (In Slavic).

Review of the development of electric power generating reactors indicated that while the economic factors are important, other criteria must be also taken into account. Reactor systems proposed for Yugoslavia must be investigated in the light of the status of the whole power-generating industry, considering long-range plans and foreign relations. Various reactor systems, such as light-water, enriched-uranium, natural-uranium or slightly enriched and gas-cooled or heavy-water-moderated reactors, were examined, raising also the problem of burners versus breeders. No one type of reactor was found to be clearly superior to the others for use in Yugoslavia. It was concluded that nuclear power plants with a capacity between 300 and 500 MWe could become strongly competitive in regions in which the fuel must be transported from great distances. The reactor plants must meet strict criteria of reliability and economy; their construction must be included in a carefully conceived, long-range plan. (TTT)

24996 OPTIMISATION, STANDARDISATION, AND AN ECONOMIC COMPARISON OF NUCLEAR POWER STATIONS. Schwarz, Dietrich. At. Strom., No. 1, 13-16(Jan. 1968). (In German).

In contradistinction to the continuously varying maximum boiler output from power stations using fossil fuels, the maximum thermal reactor outputs from nuclear stations vary in steps due to the nuclear geometry. For the economic comparison of nuclear power stations having different reactor types a certain deviation is permitted of the electrical net power from one to another, and then in the power production costs to take into account the degression of the specific installation costs with a higher installed power. (auth)

24997 STEAM GENERATORS FOR NUCLEAR POWER PLANTS WITH HIGH PRESSURE GAS CYCLES. Krizek, V. Tech. Dig. (Prague), 9: 113-16(Feb. 1967).

The first Czech nuclear power station is rated at 150 MWe with three 50 MW turbogenerators served by two steam generators each. The CO_2 leaves the reactor at 57 atm and 425°C and produces steam at 32 atm and 400°C which is mixed with low pressure steam at 2.2 atm and 185°C after the first turbine stage. The design and construction of the steam generators are described. (auth)

24998 OUTLINE OF THE (CIVIL) ENGINEERING WORKS AT THE FUKUSHIMA ATOMIC POWER STATION. 2. Saeki, Masaharu (Tokyo Electric Power Co., Inc.). Doboku Gijutsu, 22: No. 10, 89-98(Oct. 1967). (In Japanese).

A description is made of the scheme of water in-take in a "harbor," and the materials used in the construction of the breakwaters. The harbor-type water in-take was adopted by the considerations of economy, ease in construction and maintenance, and future expansion of the power station, and also of utilization of the facility as an actual harbor. The harbor site condition, and the waterbreaks are described. Riprap and concrete blocks are used in the building of the breakwaters. Nearby hills are blasted to obtain the riprap. The hills, including the blasting and transport, the aggregate-producing plant, and concrete and concrete blocks are described. (NSA of Japan)

24999 FEASIBILITY STUDY OF A 1000 MW(e) BWR UTILIZING A PRESTRESSED CONCRETE PRESSURE VESSEL. Boggio, G. (Euratom, Brussels). pp 397-443 of Development of Light Water Reactors in the Community. Brussels, Euratom, 1967.

See EUR-3561; CONF-661134.

The conceptual design studies performed to determine the most suitable BWR concept to utilize a prestressed concrete pressure vessel are reviewed. The reactor selected is installed in a cylindrical PCPV, operates at 1000 psig and features free surface steam separation and feedwater driven jet pumps for recirculation of coolant flow. A reference design plant of 1000 MW(e) was established and is briefly outlined. The vessel thermal insulation R & D program is presented with the results of thermal conductivity measurements of the different materials investigated. (auth)

25000 ECONOMIC ENERGY EVALUATION OF THE ATTAINED POSITION IN THE DEVELOPMENT OF NUCLEAR POWER STATIONS. Michaelis, H. (Euratom, Brussels). pp 1-28 of Development of Light Water Reactors in the Community. Brussels, Euratom, 1967. (In German).

See EUR-3561; CONF-661134.

A discussion on the economic aspects of the European nuclear power industry is given. The total amount of power (in MWe) planned and presently available is summarized. Economic factors peculiar to each type of reactor are discussed. Power requirements for West Germany, France, Italy, Belgium, and the Netherlands are tabulated. Fuel resources are considered. 10 references. (M.L.S.)

25001 TECHNICAL CHARACTERISTICS AND ECONOMICS OF A 600 MW(e) BOILING WATER REACTOR USING TWISTED-TAPE FUEL ASSEMBLIES. du Boucheron, G. (SNECMA, Suresne, France). pp 125-44 of Development of Light Water Reactors in the Community. Brussels, Euratom, 1967. (In French).

See EUR-3561; CONF-661134.

Factors limiting power increase in boiling water reactors (BWR) are discussed. Core configurations for 4 reference-design BWRs using twisted tape fuel elements are tabulated; economic characteristics are listed. Characteristics of required coolant pumps are given; factors affecting fuel cycle economics are tabulated. Shielding requirements are given. Economic conditions and factors are detailed. (M.L.S.)

25002 NOISE MEASUREMENTS AND OSCILLATOR TESTS ON THE GARIGLIANO REACTOR. Bastl, W.; Schnurer, H. (Technische Hochschule, Munich). pp 213-45 of Development of Light Water Reactors in the Community. Brussels, Euratom, 1967. (In German).

See EUR-3561; CONF-661134.

A description of the noise measurements and oscillator tests carried out in the Garigliano Power Reactor is given. Experiment conditions are tabulated; block diagrams of the measurement apparatus are shown; a core cross section shows the in-core instrumentation and neutron flux measuring devices in the thermal shield. Methods for interpretation of the data are described. Results of cross correlation techniques for transfer function measurements are detailed; filter method techniques are discussed also. (M.L.S.)

25003 CONTRIBUTION TO THE STUDY OF CORE DYNAMIC BEHAVIOR IN A BOILING WATER REACTOR. Levan, S.; Badiali, J. (Societe Alsthom, Paris). pp 485-520 of Development of Light Water Reactors in the Community. Brussels, Euratom, 1967. (In French).

See EUR-3561; CONF-661134.

Studies on dynamic behavior of boiling water reactor cores are described. The computer code CICA is described; the physical model, which serves as a basis for this code, is outlined. The mathematical model is given; this includes neutron multiplication, thermal transients in the fuel, thermodynamics and hydrodynamics of the fuel, and reactivity calculations. (M.L.S.)

25004 INVESTIGATION OF THE HEAT AND FLOW SYSTEM CHARACTERISTICS OF LARGE LIGHT-WATER POWER REACTORS. Braun, W.; Kafka, P.; Ulrych, G. (Siemens AG, Erlangen, Ger.). pp 295-306 of Development of Light Water Reactors in the Community. Brussels, Euratom, 1967. (In German).

See EUR-3561; CONF-661134.

A discussion of the effects of hot channel factors on power output from water-cooled power reactors is given; typical hot channel factor values are listed. Experimental apparatus and procedures for heat transfer and fluid flow measurements in the power reactors are described. The interrelation between hot channel factors and coolant temperature is shown graphically; the calculational model for the determination of local temperature variations is given. Coolant flow velocity distributions are shown. (M.L.S.)

25005 EXPERIMENTAL RESEARCH ON CENTRIFUGAL TWO-PHASE DISCHARGE-FLOW. Moussez, C.; Rosuel, A. (SNECMA, Paris). pp 99-123 of Development of Light Water Reactors in the Community. Brussels, Euratom, 1967. (In French).

See EUR-3561; CONF-661134.

Experience in the hydrodynamics of air-water mixtures at low pressure that permits the description of effects attending centrifugation in the discharge-flow regime and of the distribution of phases in a right cross section of the channel is reviewed. These investigations have resulted in the definition of the coefficient of friction law in single phase and have permitted correlation of the two-phase pressure losses and the void fraction as a function of the parameters defining the discharge flow. The improvement in thermal performance obtained from centrifugation of two-phase mixtures at 70 bars is examined. Tests were con-

ducted on tabular sections and clusters of bars. In the latter configuration critical flux is augmented by 80% for entry conditions bordering on saturation. Finally, some comments are made on the technological problems posed by the manufacture of reactor fuel elements fitted with spirals and on endurance tests conducted in loops. (tr-auth)

25006 DEVELOPMENT AND TESTING OF FUEL ELEMENTS FOR THE SUPERHEATED STEAM REACTOR GROSSWELZHEIM (HDR). Hoechel, J. (Allgemeine Elektricitaets-Gesellschaft, Frankfurt am Main). pp 521-64 of Development of Light Water Reactors in the Community. Brussels, Euratom, 1967. (In German).

See EUR-3561; CONF-661134.

A description of the prototype boiling superheat fuel elements for the Grosswelzheim Superheat Reactor is given. Results of a cladding materials analysis are tabulated; strength factors are given. Plastic deformation of clad material is shown as a function of time. Effects of steel clad and zirconium clad on fuel element lifetime are evaluated. Fuel irradiation testing in the Kahl Reactor is described; data are tabulated. Design parameters for a small superheat test fuel element are given. 11 references. (M.L.S.)

25007 PLUTONIUM LOADING IN THE SAXTON REACTOR. Bindler, L.; Deramaix, P. (CEN-Belgo Nucleaire, Brussels). pp 307-34 of Development of Light Water Reactors in the Community. Brussels, Euratom, 1967. (In French).

See EUR-3561; CONF-661134.

The plutonium fuel development program, utilizing the Saxton Power Reactor, is described; a description of the plutonium fuel elements is given. A comparison of uranium and plutonium as fuel for a pressurized water reactor is presented; calculational techniques for cell parameters, diffusion theory calculations, and burnup determinations are discussed. Criticality studies and experiments with the plutonium fuel elements are outlined. 16 references. (M.L.S.)

25008 DEVELOPMENT OF PLUTONIUM FUELS AND STUDIES OF PLUTONIUM RECYCLING IN LIGHT WATER REACTORS. Bairiot, H. (Belgo Nucleaire, Brussels); Debrue, J.; de Waegh, F.; Fossoul, E.; Motte, F.; Vanden Bemden, E.; Van Lierde, W. pp 335-78 of Development of Light Water Reactors in the Community. Brussels, Euratom, 1967. (In French).

See EUR-3561; CONF-661134.

Use of plutonium recycle in thermal water-cooled power reactors is discussed; economics are considered. The development of the fuel is outlined; fabrication, nondestructive testing and radiation testing are discussed. Thermal studies and neutronics calculational methods are described. Criticality studies using plutonium fuel elements in the VENUS critical assembly, fission ratio measurements, and neutron spectra determinations are outlined. All data are tabulated. 35 references. (M.L.S.)

25009 STUDY OF A PRESTRESSED CONCRETE VESSEL FOR A 1000 MW(e) BOILING WATER REACTOR. Tarbes, B.; Happich, J. P. (Societe d'Etudes et d'Equipements d'Entreprises, Paris). pp 445-83 of Development of Light Water Reactors in the Community. Brussels, Euratom, 1967. (In French).

See EUR-3561; CONF-661134.

Optimisation of conceptual designs of prestressed concrete reactor vessels (PCRV) for 1000 MW(e) boiling water reactors is discussed; results of studies are shown, data are tabulated. Spherical and cylindrical shapes are considered. Construction of the PCRV is discussed briefly. (M.L.S.)

25010 OPTIMIZATION AND STANDARDIZATION OF PRINCIPLE REACTOR EQUIPMENT UNDER WATER PRESSURE. Marique, L. A.; Klees, P.; Saint-Paul, R. G. (ACEC, Charleroi, Belg.). pp 287-93 of Development of Light Water Reactors in the Community. Brussels, Euratom, 1967. (In French).

See EUR-3561; CONF-661134.

Characteristics of the hot leg of the primary piping are given as a function of modulus of the primary loop. Design parameters of the primary loops and steam generators are tabulated. The net resultant electric power is listed as a function of the standard equipment and loops in the primary circuit. Characteristics of the reactor tank are tabulated as a function of normalized power. (M.L.S.)

25011 PRESSURE VESSELS OF PRESTRESSED CONCRETE FOR WATER COOLED REACTORS. Ziegler, Albert (Siemens AG, Erlangen, Ger.). pp 273-85 of Development of Light Water Reactors in the Community. Brussels, Euratom, 1967. (In German).

See EUR-3561; CONF-661134.

The specifications for prestressed concrete reactor vessels (PCRV) for water cooled reactors are given. Procedures for stress calculations for the PCRV are reviewed. Insulating and lining problems are considered; results of model experiments and testing are discussed. (M.L.S.)

25012 THE DEVELOPMENT OF THE CONTROL ROD DRIVES OF THE AEG. Ullrich, W. (Allgemeine Elektricitaets-Gesellschaft, Frankfurt am Main). pp 247-72 of Development of Light Water Reactors in the Community. Brussels, Euratom, 1967. (In German).

See EUR-3561; CONF-661134.

The basic requirements for control rods for boiling water reactors are discussed. Detailed cross sections of normal- and quick-disconnect control rods are given. Fabrication of prototype drives for the Lingen Power Reactor is described; drive characteristics are discussed. (M.L.S.)

25013 THE DEVELOPMENT OF THE AEG-STEAM SEPARATORS. Lochmann, K.-H. (Allgemeine Elektricitaets-Gesellschaft, Frankfurt am Main). pp 145-59 of Development of Light Water Reactors in the Community. Brussels, Euratom, 1967. (In German).

See EUR-3561; CONF-661134.

The effects of steam separation on reactor power output are discussed; the requirements of the steam separator in a boiling water reactor are outlined. The various types of steam separators are discussed; cross-section diagrams of each system are shown. The steam conversion system for the Lingen Power Reactor is described; operations parameters are given. 11 references. (M.L.S.)

25014 ARRANGEMENT OF THE COOLANT CIRCULATION PUMP INSIDE THE PRESSURE VESSEL OF A BOILING WATER REACTOR. Traube, K. (Allgemeine Elektricitaets-Gesellschaft, Frankfurt am Main). pp 43-62 of Development of Light Water Reactors in the Community. Brussels, Euratom, 1967. (In German).

See EUR-3561; CONF-661134.

The development of the circulation system for boiling water reactors (BWR) is outlined. Descriptions of the BWR with radial pumps, external to the pressure vessel, and axial pumps, internal to the pressure vessel, are given. A detailed cross-section of the axial pump is shown. Construction and operation of these pumps are discussed. The effects on reactor availability are described; coolant throughput and minimal burnout are shown as a function of time. Design parameters for a prototype pump are tabulated. (M.L.S.)

25015 DESCRIPTION OF TESTS TO BE CONDUCTED ON THE TRINO VERCELLESE POWER PLANT UNDER THE ENEL-EURATOM RESEARCH PROGRAM. Campiani, A.; Cioli, F. (Ente Nazionale per l'Energia Elettrica, Rome). pp 379-96 of Development of Light Water Reactors in the Community. Brussels, Euratom, 1967.

See EUR-3561; CONF-661134.

ENEL's Research Program of the Trino Vercellese station covers four major areas: power density distribution, reactivity characteristics, reactor power capability, and chemical shim performance. In a concurrent program, the Nuclear Section of FIAT will perform the calculations required to support the collection and the analysis of the experimental data obtained during the various phases of ENEL's Program. The design calculation models will also be checked against the experimental data. (auth)

25016 RESULTS OF THE SPECIAL TESTS CONDUCTED AT THE GARIGLIANO BWR POWER STATION UNDER THE RESEARCH AND DEVELOPMENT PROGRAM. Mirone, M. (ENEL, Latina, Italy); Santasilia, F.; Colling, A. pp 161-93 of Development of Light Water Reactors in the Community. Brussels, Euratom, 1967.

See EUR-3561; CONF-661134.

In compliance with the Research and Development Program, a number of special tests were conducted on the Garigliano nuclear power station to demonstrate the capability of the reactor to operate with a high void content. The tests performed are briefly described and the results obtained under different void and core inlet subcooling conditions are summarized. The data are compared with normal operating data. A few comments are made on the performance of the special equipment installed for the Research Program, with special amphasis on the computer, movable incore ionization chambers and the instrumented fuel assemblies. The preliminary results of the stability tests performed by oscillation of the central control rod are given. (auth)

25017 MODERN BOILING WATER REACTOR AND ITS TECHNICAL SAFETY ASPECTS. Kornbichler, H. (Allgemeine Elektricitaes-Gesellschaft, Frankfurt am Main). pp 29-41 of Develop-

ment of Light Water Reactors in the Community. Brussels, Euratom, 1967. (In German).

See EUR-3561; CONF-661134.

Characteristic parameters for commercial BWRs are given; the complete internal water coolant circuit is described. Various safety aspects are delineated. These include the origin and transport of fission product activity under normal operating conditions and a listing of types of probable accidents with methods for control. (M.L.S.)

25018 STABILITY ANALYSIS FOR BOILING WATER REACTORS. Kirchenmayer, A. (Allgemeine Elektricitaets-Gesellschaft, Frankfurt am Main). pp 75-84 of Development of Light Water Reactors in the Community. Brussels, Euratom, 1967. (In German).

See EUR-3561; CONF-661134.

Feedback effects in boiling water reactors (BWR) are discussed. Methods for theoretical and experimental investigation of these effects are outlined. (M.L.S.)

25019 A 500 MW BHWR TYPE NUCLEAR POWER PLANT. Jovanic, Milan; Mojovic, Ljubomir. Nukl. Energ., 5: No. 4, 7-15 (1967). (In Slovak).

A 500 MW(e) nuclear power plant consists of a reactor with natural U and heavy water boiling in the fuel channels. The reactor core is placed in a prestressed concrete vessel which together with a system of pressure damping makes a unified structure. The circulation of the coolant in the core is natural. The steam cycle is direct and two turbo-generators are used in the direct steam cycle. The fuel discharge is continuous and applicable at full load of the reactor enabling thus a high availability of the power plant. The plant has been designed for base loads and is capable of automatically adjusting to load variations in a 75 to 100% range. Through special design the output of the reactor can be under 75%, and come down even to zero, enabling the plant to resume operation in the grid after a short complete unloading. (auth)

25020 COMBINATION NUCLEAR AND CONVENTIONAL THERMAL POWER PLANTS. Vuia, Romul E. Nukl. Energ., 5: No. 4, 16-23(1967). (In Slovak).

The CANDU type nuclear power plant is in a competitive position in large unit sizes, when compared with the conventional thermal power plant, in areas of high fossil fuel costs, such as prevailing in the provinces of Ontario and Quebec. This will be even more so after the first and the second generations of nuclear power reactors prove themselves in operation. However, due to the relatively high capital cost, this competitiveness is strongly affected by high fixed charge rates and low load factors, primarily in the lower and medium capacity range. A concept which combines a nuclear steam supply system with a conventional fossil fired power plant, by superheating the saturated nuclear steam, resulting in a considerable reduction in capital investment for the same capacity, was recently developed. Besides combining favorably the advantages of both systems—nuclear and conventional—the Combined Power Plant will produce electricity at lower costs, for a certain size and fuel cost range, under base and swinging load conditions, when compared with either type of power plant, over a wide range of fixed charge rates and load factors. 35 references. (auth)

25021 USE OF TWISTED TAPES FOR INCREASING THE POWER DENSITY OF BOILING-WATER REACTORS. EUROPEAN TYPE OF BOILING-WATER REACTOR. Rosuel, A.; Rouvillois, X. Energ. Nucl. (Paris), 9: 496-500(Dec. 1967). (In French).

The first results of the tests carried out in the Kahl reactor on an experimental fuel assembly with gyratory flow in the pipes drew the attention of technicians to a European-type of boiling-water reactor with high power density. (B.G.D.)

25022 SAFETY ENGINEERING METHODS FOR NUCLEAR INSTALLATIONS. Battistini, Giulio (Univ., Pisa, Italy). Ing. Nucl., 8: No. 5, 3-10(Sept.-Oct. 1967). (In Italian).

A survey of the history of safety practices in and around nuclear installations is given. The concept of passive containment is discussed; pressure suppression and double containment concepts are described. Consideration of the safety of the installation as a whole is given. These safety concepts are discussed with reference to the Italian nuclear installations. (M.L.S.)

25023 SAN ONOFRE STARTUP. Fogarty, David J.; Ortega, Orlando J. (Southern California Edison Co., Los Angeles). Power Eng., 72: No. 4, 38-40(Apr. 1968).

A description of the startup procedures for the San Onofre Power Reactor is presented. The three phase startup program included: precritical testing and core loading; core loading through cold and hot zero power physics testing programs; and synchronization of the unit with the system to acceptance for commercial operation. Problems encountered during startup are described. (D.C.C.)

25024 NUCLEAR PLANT PROTECTIVE SYSTEMS. Nathan, A. (Sargent and Lundy, Chicago). Power Eng., 72: No. 3, 64-7 (Mar. 1968).

The reactor scram portion of the total protective system of a nuclear power plant. Requirements for initiating protective actions are outlined; channel logic is shown diagrammatically. Interlocks between protective systems or operating modes are listed; control rod drive interlocks are given. Design philosophy for the safety and control systems is discussed. Radiation monitoring points for a typical direct-cycle plant are tabulated. (M.L.S.)

25025 MONOTUBULAR STEAM GENERATOR CONSTRUCTED BY GECEN UNDER SULZER LICENCE FOR EDF 4 NUCLEAR POWER STATION (SAINT-LAURENT-DES-EAUX) OF THE ELECTRICITE DE FRANCE. Prost, M. Atompraxis, 14: 18-20(Jan. 1968). (In German).

The monotubular steam generator constructed by Sulzer for the nuclear power reactor EDF 4 in Saint-Laurent-des-Eaux can be characterized as a remarkable step of development in the succession of the gas-cooled reactors. Fabrication of the steam generator is described. (auth)

25026 MEASUREMENT OF REACTIVITY BY THE METHOD OF SIGNAL REDUCTION. Smirnov, N. A. (Inst. of Automation and Remote Control, Moscow). Vestsi Akad. Navuk BSSR, Ser. Fiz.-Tekh. Navuk, No. 4, 5-12(1967). (In Russian).

The measurement of reactivity by the method of signal reduction in contrast to other methods does not require interference with the operation of the reactor and makes it possible to obtain the magnitude of the reactivity directly without supplementary calculation. For the measurement of small increments of reactivity, a method for the synthesis of a system, optimum in the sense of minimum mean square error, is given. A scheme for the measurement is presented for the case where the neutron output is observed in the presence of white noise and interference. It is shown how this satisfactorily simple scheme can be used for the filtration of interference and not affect the white noise. For measurement of the reactivity in all ranges of its changes it is recommended that the scheme constructed on the principle of a system filtering high-frequency interference be used. A scheme characterized by improved dynamic behavior is proposed. (tr-auth)

25027 THEORETICAL CONSIDERATION OF THE POWER VARIATION IN A WATER REACTOR AT THE LOSS-OF-COOLANT ACCIDENT. Takekoshi, Tadasu; Kohga, Masayuki; Sato, Hiroyuki; Amano, Fumio; Sunako, Katsuhiko. Denki Shikensho Iho, 31: 1169-84(1967). (In Japanese).

An analysis of the power variation in a water reactor after the loss-of-coolant accident by employing digital and analog computers is described. The main emphasis is concentrated upon simplified approaches to the reactor dynamic characteristic equations. Numerical parameters such as the variation rate of reactivity; the number of delayed neutrons and the neutron life time are taken into account. The conclusion derived from the numerical calculations shows that the results obtained by the digital computer are almost in agreement with the results by the analog computer. It is confirmed that the method of Runge-Kutta is not suitable, but that the method of Runge-Kutta-Merson is suitable for the numerical calculations, and that even a simplified form of the approach is enough for designing the electrical power source for a loss-of-coolant accident simulator. (auth)

25028 NUCLEAR ENERGY IN SPAIN. PART II. SPANISH NUCLEAR PROGRAM AND FUTURE FORCASTS. Neue Tech., 10: No. B1, 25-30(Feb. 1968). (In Spanish).

A survey of power needs for Spain is given. Predictions of requirements and installed power are presented for 1968–1971; this includes nuclear, hydroelectric, and thermal. The power reactors planned for Spain are described. (M.L.S.)

25029 NUCLEAR POWER PLANTS AND VERSATILE NUCLEAR POWER INSTALLATIONS. Wiesenack, Guenter (Technische Ueberwachungs-Vereine e. V., Essen). VDI (Ver. Deut. Ing.) Z., 110: 141-6(Feb. 1968). (In German).

A survey of world nuclear power plants and installed nuclear power is given. Safety questions are considered briefly. Installed nuclear power capacity is then discussed according to country, these being: EURATOM, Belgium, West Germany, France, Great Britain, Italy, Japan, and the USA. Other countries are discussed as a whole. Shipboard and space reactors are discussed briefly. 95 references. (M.L.S.)

ducted on tabular sections and clusters of bars. In the latter configuration critical flux is augmented by 80% for entry conditions bordering on saturation. Finally, some comments are made on the technological problems posed by the manufacture of reactor fuel elements fitted with spirals and on endurance tests conducted in loops. (tr-auth)

25006 DEVELOPMENT AND TESTING OF FUEL ELEMENTS FOR THE SUPERHEATED STEAM REACTOR GROSSWELZHEIM (HDR). Hoechel, J. (Allgemeine Elektricitaets-Gesellschaft, Frankfurt am Main). pp 521-64 of Development of Light Water Reactors in the Community. Brussels, Euratom, 1967. (In German).

See EUR-3561; CONF-661134.

A description of the prototype boiling superheat fuel elements for the Grosswelzheim Superheat Reactor is given. Results of a cladding materials analysis are tabulated; strength factors are given. Plastic deformation of clad material is shown as a function of time. Effects of steel clad and zirconium clad on fuel element lifetime are evaluated. Fuel irradiation testing in the Kahl Reactor is described; data are tabulated. Design parameters for a small superheat test fuel element are given. 11 references. (M.L.S.)

25007 PLUTONIUM LOADING IN THE SAXTON REACTOR. Bindler, L.; Deramaix, P. (CEN-Belgo Nucleaire, Brussels). pp 307-34 of Development of Light Water Reactors in the Community. Brussels, Euratom, 1967. (In French).

See EUR-3561; CONF-661134.

The plutonium fuel development program, utilizing the Saxton Power Reactor, is described; a description of the plutonium fuel elements is given. A comparison of uranium and plutonium as fuel for a pressurized water reactor is presented; calculational techniques for cell parameters, diffusion theory calculations, and burnup determinations are discussed. Criticality studies and experiments with the plutonium fuel elements are outlined. 16 references. (M.L.S.)

25008 DEVELOPMENT OF PLUTONIUM FUELS AND STUDIES OF PLUTONIUM RECYCLING IN LIGHT WATER REACTORS. Bairiot, H. (Belgo Nucleaire, Brussels); Debrue, J.; de Waegh, F.; Fossoul, E.; Motte, F.; Vanden Bemden, E.; Van Lierde, W. pp 335-78 of Development of Light Water Reactors in the Community. Brussels, Euratom, 1967. (In French).

See EUR-3561; CONF-661134.

Use of plutonium recycle in thermal water-cooled power reactors is discussed; economics are considered. The development of the fuel is outlined; fabrication, nondestructive testing and radiation testing are discussed. Thermal studies and neutronics calculational methods are described. Criticality studies using plutonium fuel elements in the VENUS critical assembly, fission ratio measurements, and neutron spectra determinations are outlined. All data are tabulated. 35 references. (M.L.S.)

25009 STUDY OF A PRESTRESSED CONCRETE VESSEL FOR A 1000 MW(e) BOILING WATER REACTOR. Tarbes, B.; Happich, J. P. (Societe d'Etudes et d'Equipements d'Entreprises, Paris). pp 445-83 of Development of Light Water Reactors in the Community. Brussels, Euratom, 1967. (In French).

See EUR-3561; CONF-661134.

Optimisation of conceptual designs of prestressed concrete reactor vessels (PCRV) for 1000 MW(e) boiling water reactors is discussed; results of studies are shown, data are tabulated. Spherical and cylindrical shapes are considered. Construction of the PCRV is discussed briefly. (M.L.S.)

25010 OPTIMIZATION AND STANDARDIZATION OF PRINCIPLE REACTOR EQUIPMENT UNDER WATER PRESSURE. Marique, L. A.; Klees, P.; Saint-Paul, R. G. (ACEC, Charleroi, Belg.). pp 287-93 of Development of Light Water Reactors in the Community. Brussels, Euratom, 1967. (In French).

See EUR-3561; CONF-661134.

Characteristics of the hot leg of the primary piping are given as a function of modulus of the primary loop. Design parameters of the primary loops and steam generators are tabulated. The net resultant electric power is listed as a function of the standard equipment and loops in the primary circuit. Characteristics of the reactor tank are tabulated as a function of normalized power. (M.L.S.)

25011 PRESSURE VESSELS OF PRESTRESSED CONCRETE FOR WATER COOLED REACTORS. Ziegler, Albert (Siemens AG, Erlangen, Ger.). pp 273-85 of Development of Light Water Reactors in the Community. Brussels, Euratom, 1967. (In German).

See EUR-3561; CONF-661134.

The specifications for prestressed concrete reactor vessels (PCRV) for water cooled reactors are given. Procedures for stress calculations for the PCRV are reviewed. Insulating and lining problems are considered; results of model experiments and testing are discussed. (M.L.S.)

25012 THE DEVELOPMENT OF THE CONTROL ROD DRIVES OF THE AEG. Ullrich, W. (Allgemeine Elektricitaets-Gesellschaft, Frankfurt am Main). pp 247-72 of Development of Light Water Reactors in the Community. Brussels, Euratom, 1967. (In German).

See EUR-3561; CONF-661134.

The basic requirements for control rods for boiling water reactors are discussed. Detailed cross sections of normal- and quick-disconnect control rods are given. Fabrication of prototype drives for the Lingen Power Reactor is described; drive characteristics are discussed. (M.L.S.)

25013 THE DEVELOPMENT OF THE AEG-STEAM SEPARATORS. Lochmann, K.-H. (Allgemeine Elektricitaets-Gesellschaft, Frankfurt am Main). pp 145-59 of Development of Light Water Reactors in the Community. Brussels, Euratom, 1967. (In German).

See EUR-3561; CONF-661134.

The effects of steam separation on reactor power output are discussed; the requirements of the steam separator in a boiling water reactor are outlined. The various types of steam separators are discussed; cross-section diagrams of each system are shown. The steam conversion system for the Lingen Power Reactor is described; operations parameters are given. 11 references. (M.L.S.)

25014 ARRANGEMENT OF THE COOLANT CIRCULATION PUMP INSIDE THE PRESSURE VESSEL OF A BOILING WATER REACTOR. Traube, K. (Allgemeine Elektricitaets-Gesellschaft, Frankfurt am Main). pp 43-62 of Development of Light Water Reactors in the Community. Brussels, Euratom, 1967. (In German).

See EUR-3561; CONF-661134.

The development of the circulation system for boiling water reactors (BWR) is outlined. Descriptions of the BWR with radial pumps, external to the pressure vessel, and axial pumps, internal to the pressure vessel, are given. A detailed cross-section of the axial pump is shown. Construction and operation of these pumps are discussed. The effects on reactor availability are described; coolant throughput and minimal burnout are shown as a function of time. Design parameters for a prototype pump are tabulated. (M.L.S.)

25015 DESCRIPTION OF TESTS TO BE CONDUCTED ON THE TRINO VERCELLESE POWER PLANT UNDER THE ENEL-EURATOM RESEARCH PROGRAM. Campiani, A.; Cioli, F. (Ente Nazionale per l'Energia Elettrica, Rome). pp 379-96 of Development of Light Water Reactors in the Community. Brussels, Euratom, 1967.

See EUR-3561; CONF-661134.

ENEL's Research Program of the Trino Vercellese station covers four major areas: power density distribution, reactivity characteristics, reactor power capability, and chemical shim performance. In a concurrent program, the Nuclear Section of FIAT will perform the calculations required to support the collection and the analysis of the experimental data obtained during the various phases of ENEL's Program. The design calculation models will also be checked against the experimental data. (auth)

25016 RESULTS OF THE SPECIAL TESTS CONDUCTED AT THE GARIGLIANO BWR POWER STATION UNDER THE RESEARCH AND DEVELOPMENT PROGRAM. Mirone, M. (ENEL, Latina, Italy); Santasilia, F.; Colling, A. pp 161-93 of Development of Light Water Reactors in the Community. Brussels, Euratom, 1967.

See EUR-3561; CONF-661134.

In compliance with the Research and Development Program, a number of special tests were conducted on the Garigliano nuclear power station to demonstrate the capability of the reactor to operate with a high void content. The tests performed are briefly described and the results obtained under different void and core inlet subcooling conditions are summarized. The data are compared with normal operating data. A few comments are made on the performance of the special equipment installed for the Research Program, with special amphasis on the computer, movable incore ionization chambers and the instrumented fuel assemblies. The preliminary results of the stability tests performed by oscillation of the central control rod are given. (auth)

25017 MODERN BOILING WATER REACTOR AND ITS TECHNICAL SAFETY ASPECTS. Kornbichler, H. (Allgemeine Elektricitaes-Gesellschaft, Frankfurt am Main). pp 29-41 of Develop-

ment of Light Water Reactors in the Community. Brussels, Euratom, 1967. (In German).

See EUR-3561; CONF-661134.

Characteristic parameters for commercial BWRs are given; the complete internal water coolant circuit is described. Various safety aspects are delineated. These include the origin and transport of fission product activity under normal operating conditions and a listing of types of probable accidents with methods for control. (M.L.S.)

25018 STABILITY ANALYSIS FOR BOILING WATER REACTORS. Kirchenmayer, A. (Allgemeine Elektricitaets-Gesellschaft, Frankfurt am Main). pp 75-84 of Development of Light Water Reactors in the Community. Brussels, Euratom, 1967. (In German).

See EUR-3561; CONF-661134.

Feedback effects in boiling water reactors (BWR) are discussed. Methods for theoretical and experimental investigation of these effects are outlined. (M.L.S.)

25019 A 500 MW BHWR TYPE NUCLEAR POWER PLANT. Jovanic, Milan; Mojovic, Ljubomir. Nukl. Energ., 5: No. 4, 7-15 (1967). (In Slovak).

A 500 MW(e) nuclear power plant consists of a reactor with natural U and heavy water boiling in the fuel channels. The reactor core is placed in a prestressed concrete vessel which together with a system of pressure damping makes a unified structure. The circulation of the coolant in the core is natural. The steam cycle is direct and two turbo-generators are used in the direct steam cycle. The fuel discharge is continuous and applicable at full load of the reactor enabling thus a high availability of the power plant. The plant has been designed for base loads and is capable of automatically adjusting to load variations in a 75 to 100% range. Through special design the output of the reactor can be under 75%, and come down even to zero, enabling the plant to resume operation in the grid after a short complete unloading. (auth)

25020 COMBINATION NUCLEAR AND CONVENTIONAL THERMAL POWER PLANTS. Vuia, Romul E. Nukl. Energ., 5: No. 4, 16-23(1967). (In Slovak).

The CANDU type nuclear power plant is in a competitive position in large unit sizes, when compared with the conventional thermal power plant, in areas of high fossil fuel costs, such as prevailing in the provinces of Ontario and Quebec. This will be even more so after the first and the second generations of nuclear power reactors prove themselves in operation. However, due to the relatively high capital cost, this competitiveness is strongly affected by high fixed charge rates and low load factors, primarily in the lower and medium capacity range. A concept which combines a nuclear steam supply system with a conventional fossil fired power plant, by superheating the saturated nuclear steam, resulting in a considerable reduction in capital investment for the same capacity, was recently developed. Besides combining favorably the advantages of both systems—nuclear and conventional—the Combined Power Plant will produce electricity at lower costs, for a certain size and fuel cost range, under base and swinging load conditions, when compared with either type of power plant, over a wide range of fixed charge rates and load factors. 35 references. (auth)

25021 USE OF TWISTED TAPES FOR INCREASING THE POWER DENSITY OF BOILING-WATER REACTORS. EUROPEAN TYPE OF BOILING-WATER REACTOR. Rosuel, A.; Rouvillois, X. Energ. Nucl. (Paris), 9: 496-500(Dec. 1967). (In French).

The first results of the tests carried out in the Kahl reactor on an experimental fuel assembly with gyratory flow in the pipes drew the attention of technicians to a European-type of boiling-water reactor with high power density. (B.G.D.)

25022 SAFETY ENGINEERING METHODS FOR NUCLEAR INSTALLATIONS. Battistini, Giulio (Univ., Pisa, Italy). Ing. Nucl., 8: No. 5, 3-10(Sept.-Oct. 1967). (In Italian).

A survey of the history of safety practices in and around nuclear installations is given. The concept of passive containment is discussed; pressure suppression and double containment concepts are described. Consideration of the safety of the installation as a whole is given. These safety concepts are discussed with reference to the Italian nuclear installations. (M.L.S.)

25023 SAN ONOFRE STARTUP. Fogarty, David J.; Ortega, Orlando J. (Southern California Edison Co., Los Angeles). Power Eng., 72: No. 4, 38-40(Apr. 1968).

A description of the startup procedures for the San Onofre Power Reactor is presented. The three phase startup program included: precritical testing and core loading; core loading through cold and hot zero power physics testing programs; and synchronization of the unit with the system to acceptance for commercial operation. Problems encountered during startup are described. (D.C.C.)

25024 NUCLEAR PLANT PROTECTIVE SYSTEMS. Nathan, A. (Sargent and Lundy, Chicago). Power Eng., 72: No. 3, 64-7 (Mar. 1968).

The reactor scram portion of the total protective system of a nuclear power plant. Requirements for initiating protective actions are outlined; channel logic is shown diagrammatically. Interlocks between protective systems or operating modes are listed; control rod drive interlocks are given. Design philosophy for the safety and control systems is discussed. Radiation monitoring points for a typical direct-cycle plant are tabulated. (M.L.S.)

25025 MONOTUBULAR STEAM GENERATOR CONSTRUCTED BY GECEN UNDER SULZER LICENCE FOR EDF 4 NUCLEAR POWER STATION (SAINT-LAURENT-DES-EAUX) OF THE ELECTRICITE DE FRANCE. Prost, M. Atompraxis, 14: 18-20(Jan. 1968). (In German).

The monotubular steam generator constructed by Sulzer for the nuclear power reactor EDF 4 in Saint-Laurent-des-Eaux can be characterized as a remarkable step of development in the succession of the gas-cooled reactors. Fabrication of the steam generator is described. (auth)

25026 MEASUREMENT OF REACTIVITY BY THE METHOD OF SIGNAL REDUCTION. Smirnov, N. A. (Inst. of Automation and Remote Control, Moscow). Vestsi Akad. Navuk BSSR, Ser. Fiz.-Tekh. Navuk, No. 4, 5-12(1967). (In Russian).

The measurement of reactivity by the method of signal reduction in contrast to other methods does not require interference with the operation of the reactor and makes it possible to obtain the magnitude of the reactivity directly without supplementary calculation. For the measurement of small increments of reactivity, a method for the synthesis of a system, optimum in the sense of minimum mean square error, is given. A scheme for the measurement is presented for the case where the neutron output is observed in the presence of white noise and interference. It is shown how this satisfactorily simple scheme can be used for the filtration of interference and not affect the white noise. For measurement of the reactivity in all ranges of its changes it is recommended that the scheme constructed on the principle of a system filtering high-frequency interference be used. A scheme characterized by improved dynamic behavior is proposed. (tr-auth)

25027 THEORETICAL CONSIDERATION OF THE POWER VARIATION IN A WATER REACTOR AT THE LOSS-OF-COOLANT ACCIDENT. Takekoshi, Tadasu; Kohga, Masayuki; Sato, Hiroyuki; Amano, Fumio; Sunako, Katsuhiko. Denki Shikensho Iho, 31: 1169-84(1967). (In Japanese).

An analysis of the power variation in a water reactor after the loss-of-coolant accident by employing digital and analog computers is described. The main emphasis is concentrated upon simplified approaches to the reactor dynamic characteristic equations. Numerical parameters such as the variation rate of reactivity; the number of delayed neutrons and the neutron life time are taken into account. The conclusion derived from the numerical calculations shows that the results obtained by the digital computer are almost in agreement with the results by the analog computer. It is confirmed that the method of Runge-Kutta is not suitable, but that the method of Runge-Kutta-Merson is suitable for the numerical calculations, and that even a simplified form of the approach is enough for designing the electrical power source for a loss-of-coolant accident simulator. (auth)

25028 NUCLEAR ENERGY IN SPAIN. PART II. SPANISH NUCLEAR PROGRAM AND FUTURE FORCASTS. Neue Tech., 10: No. B1, 25-30(Feb. 1968). (In Spanish).

A survey of power needs for Spain is given. Predictions of requirements and installed power are presented for 1968–1971; this includes nuclear, hydroelectric, and thermal. The power reactors planned for Spain are described. (M.L.S.)

25029 NUCLEAR POWER PLANTS AND VERSATILE NUCLEAR POWER INSTALLATIONS. Wiesenack, Guenter (Technische Ueberwachungs-Vereine e. V., Essen). VDI (Ver. Deut. Ing.) Z., 110: 141-6(Feb. 1968). (In German).

A survey of world nuclear power plants and installed nuclear power is given. Safety questions are considered briefly. Installed nuclear power capacity is then discussed according to country, these being: EURATOM, Belgium, West Germany, France, Great Britain, Italy, Japan, and the USA. Other countries are discussed as a whole. Shipboard and space reactors are discussed briefly. 95 references. (M.L.S.)

25030 LARGE NUCLEAR POWER PLANTS FOR DESALTING. Bull. Belgicatom, 12: No. 4, 8-12(Nov.-Dec. 1967).

The general requirements for large dual purpose systems are discussed. The status of development and construction of pressurized-water reactors, as of 1966, is given; the relationship of these reactors to the requirements of dual-purpose plants is considered. The economics of such systems is discussed. (M.L.S.)

25031 STUDY OF THE STABILITY OF A NUCLEAR POWER PLANT WITH CIRCULATING FUEL. Goryachenko, V. D.; Trunin, Yu. F. Vestsi Akad. Navuk BSSR, Ser. Fiz.-Tekh. Navuk, No. 3, 38-45(1967). (In Russian).

The development and generalization of the method of Liapunov to systems with distributed parameters makes it possible to investigate mathematically non-linear models of nuclear reactors such as reactors with circulating fuel consisting of a reactor core and a heat exchanger. The equations of motions are written for the active zone and for the heat exchanger which is a linearly distributed system. It is shown that asymptotic stability for steady-state operation takes place for any physically realizable initial deviations of the variables. First it is proved that the motion equations describe a system which is limited over a time period. Then a continuous, positively defined functional is selected, and the stability of the system is proved from the first theorem of Liapunov. Finally, starting from the properties of the functional and the initial motion equations, it is proved that whatever the initial deviations may be from a state of equilibrium, the power and other variables characterizing the reactor tend towards stationary values with an increase in time. (TTT)

25032 INTERNATIONAL CONFERENCE AND EXHIBITION ON A WORLD REVIEW OF NUCLEAR REACTORS AND RADIOISOTOPES, MONTREAL, QUEBEC, CANADA, MAY 28-31, 1967. Toronto, Canadian Nuclear Association, 1967. 556p. $20.00. (CONF-670522).

Included are 28 papers on various technical, economic, and legal aspects of worldwide development of power reactors and radioisotopes. Separate abstracts were prepared for 12 of the papers, and abstracts of 7 papers appear in previous issues of NSA. They may be located under CONF-670522 in the report number indexes. (H.D.R.)

For abstracts of individual papers see: 23232, 23233, 23249, 25033-25038, and 25155-25157.

25033 GENTILLY POWER STATION PRESTRESSED REACTOR CONTAINMENT BUILDING. Laforte, B.; Ziegler, A.; Wong, P. (Nenniger and Chenevert Inc., Montreal). 8p. of International Conference and Exhibition on a World Review of Nuclear Reactors and Radioisotopes, Montreal, Quebec, Canada, May 28-31, 1967. Toronto, Canadian Nuclear Association, 1967. (CONF-670522-18; 67-CNA-424).

Design problems, but not construction, are discussed. The inside diameter of the concrete perimeter wall is 120 ft and the overall height 188 ft. To permit elastic deformations caused by shrinkage and creep, the base slab is placed on a sliding membrane consisting of two polyethylene sheets with grease between them. This in turn is placed on a concrete sub-base resting on bedrock. Shear keys ensure stability against earthquake forces. Safety against radiation, leaks, and rupture are among other design features outlined. The prestressing system is described. (F.S.A.)

25034 FAST BREEDER POWER REACTORS: A WORLD OUTLOOK. Seaborg, G. T. (Atomic Energy Commission, Washington, D. C.). 13p. of International Conference and Exhibition on a World Review of Nuclear Reactors and Radioisotopes, Montreal, Quebec, Canada, May 28-31, 1967. Toronto, Canadian Nuclear Association, 1967. (CONF-670522-19; 67-CNA-421).

The various national fast breeder reactor programs are reviewed with an assessment of their limitations and problems. (F.S.A.)

25035 COMBINATION NUCLEAR AND CONVENTIONAL THERMAL POWER PLANT. Vuia, R. E. (Combustion Engineering-Superheater Ltd., Montreal). 14p. of International Conference and Exhibition on a World Review of Nuclear Reactors and Radioisotopes, Montreal, Quebec, Canada, May 28-31, 1967. Toronto, Canadian Nuclear Association, 1967. (CONF-670522-20; 67-CNA-425).

The CANDU type nuclear power plant is in a competitive position in large unit sizes, when compared with the conventional thermal power plant, in areas of high fossil fuel costs, such as prevailing in the Provinces of Ontario and Quebec. This will be even more so after the first and the second generations of nuclear power reactors prove themselves in operation. However, due to the relatively high capital cost, this competitiveness is strongly affected by high fixed charge rates and low load factors, primarily in the lower and medium capacity range. A concept which combines a nuclear steam supply system with a conventional fossil fired power plant, by superheating the saturated nuclear steam, resulting in a considerable reduction in capital investment for the same capacity, was recently developed. Besides combining favorably the advantages of both systems-nuclear and conventional-the Combined Power Plant will produce electricity at lower costs, for a certain size and fuel cost range, under base and swinging load conditions, when compared with either type of power plant, over a wide range of fixed charge rates and load factors. (auth)

25036 COMMISSIONING AND EARLY OPERATION OF DOUGLAS POINT. Austman, H. L. (Douglas Point Operations, Ont.). 17p. of International Conference and Exhibition on a World Review of Nuclear Reactors and Radioisotopes, Montreal, Quebec, Canada, May 28-31, 1967. Toronto, Canadian Nuclear Association, 1967. (CONF-670522-9; 67-CNA-414).

A brief history of the commissioning is presented followed by a more detailed description of some problems. An outline of the station operating organization is also given. (auth)

25037 SYSTEM PLANNING AND NUCLEAR GENERATION. 25p. of International Conference and Exhibition on a World Review of Nuclear Reactors and Radioisotopes, Montreal, Quebec, Canada, May 28-31, 1967. Toronto, Canadian Nuclear Association, 1967. (CONF-670522-13; 67-CNA-407).

The electrical energy that will be required to meet the future needs of Canada and the world will depend more and more on nuclear generation. To integrate this future generation in an existing system, the planning engineers when studying alternative system expansion programs involving nuclear generation have to evaluate a host of technical and economic factors which will have a bearing on the choice of program. Considerations pertaining to unit size, cost and operating characteristics of nuclear reactors are discussed in the light of system and load characteristics, followed by an economic and financial analysis. The important point to note is that for every electrical system there is a particular solution based on the requirements of the system: its size, the financial burdens that it can carry and most of all its existing generation and load characteristics. (auth)

25038 INTERNATIONAL VIEW OF HEAVY WATER MODERATED REACTORS. Gray, J. L. (Atomic Energy of Canada Ltd., Chalk River, Ont.); Laurila, E.; Meckoni, N. V.; Stewart, J. C. C.; Usmani, J. H. 41p. of International Conference and Exhibition on a World Review of Nuclear Reactors and Radioisotopes, Montreal, Quebec, Canada, May 28-31, 1967. Toronto, Canadian Nuclear Association, 1967. (CONF-670522-14; 67-CNA-427).

The demand for electrical power in India is reviewed, and the program for construction of nuclear power stations is discussed. The economics of uranium utilization in various reactor systems is examined, with particular emphasis on CANDU-type reactors. The United Kingdom nuclear power program is reviewed, and the place of heavy water moderated reactors in this program is evaluated. Prospects and problems for the utilization of heavy water reactors in the Pakistan power program are discussed. Projected energy demands and resources for Pakistan are presented, and the economics of various power generation systems are examined. (H.D.R.)

25039 IMPROVEMENTS RELATING TO GAS-COOLED NUCLEAR REACTORS. Lind, Robert; Campion, Peter (to United Kingdom Atomic Energy Authority). British Patent 1,108,512. Apr. 3, 1968. Filed June 24, 1965.

A method of reducing water vapor concentration in a CO_2 nuclear reactor coolant is presented. The method consists of extracting hydrogen by selective diffusion through a membrane. (D.C.C.)

25040 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS. Becker, Kurt Magnus (to Aktiebolaget Atomenergi). British Patent 1,107,610. Mar. 27, 1968. Priority date July 24, 1964, Sweden.

The description of a nuclear reactor fuel assembly is presented. The assembly consists of a large flow tube with boiling water coolant and a symmetric arrangement of fuel rods. The outer wall of the flow tube has a heat insulating coating of a metal oxide. The fuel assembly is constructed so that the flow tube has a higher enrichment of uranium than the fuel rods. (D.C.C.)

25041 FLOW-LIMITING DEVICE, ESPECIALLY FOR NUCLEAR REACTORS. (to Commissariat a l'Energie Atomique). French Patent 1,440,702. Apr. 25, 1966. Filed Apr. 2, 1965.

In order to prevent the "blow-up" of fuel cartridges during on-load discharge of reactors of the upward coolant flow type being refuelled from the top face, a venturi tube is disposed on a removable debris collector or so-called "catchpot," between the coolant gas inlet ports formed in the "catchpot" and the outlet of this latter in the fuel channel. The venturi has a cross-sectional area at its throat, so that the coolant gas attains the velocity of sound at a flow rate within the channel which is lower than that which would result in a "blow-up" of the fuel cartridges. The throat of the venturi (at which the prevasting pressure is lower than the pressure upstream) is adapted to communicate with the lower end of the "catchpot" so as to result in the appearance of vertical and downwardly-acting pressure forces which apply the "catchpot" against a stationary annular supporting bulge. (IIB)

25042 A PLANNING MODEL FOR NUCLEAR FUEL RESOURCES IN THE CIVILIAN NUCLEAR POWER PROGRAM. Ling, James Gi-ming. Stanford, Calif., Stanford Univ., 1967. 141p.

Thesis.

The rapid expansion of central station nuclear power plant construction in the United States since 1964 has increased the need for Government planning and coordination in all aspects of civilian nuclear power. In particular, the Atomic Energy Commission has direct responsibilities in controlling the nuclear materials stockpile, in providing U enrichment services, in conserving nuclear fuel resources, and in sponsoring reactor development. A methodology for planning, based on a computer model, which is designed to assist the public administrator in the field of civilian nuclear power is described. The planning techniques can be summarized as a four-step procedure: determine the technological and economic characteristics of power plants which will enter the nuclear power complex; use computer simulation to determine the linear programming constraints for a mixed-reactor complex; use linear programming to determine the optimal installation pattern for each type of reactor; and use the optimal installation patterns in the simulation to determine inputs and outputs of the nuclear power complex. The simulation is written in ALGOL programming language. Typical output data include natural U requirements, Pu production, tailings discharged by U enrichment plants, separative work required in enrichment plants, the annual throughput in fuel handling facilities, and others. Several examples using combinations of light-water, heavy-water, and fast breeder reactors in the 1965 to 2010 time period are described. The results of optimization and simulation are shown. Potential applications of the planning model are discussed. (Disser Abstr.)

25043 HEAT EXTRACTION DEVICE FOR A NUCLEAR REACTOR. (to Societe Indatom). French Patent 1,449,917. July 11, 1966. Filed July 9, 1965.

A nuclear reactor of the integral exchanger type comprises a reactor core, a primary cooling fluid circuit for the core, and heat exchangers between the cooling fluid and an extraction fluid, all enclosed in a pressure resistant vessel having orifices in which blowers for circulating the primary cooling fluid are mounted. The heat extraction device comprises a detachable plug adapted for mounting in and for closing one of the orifices in the vessel. A blower for circulating the primary cooling fluid is secured to the central part of the plug. A heat exchanger is also secured to the same plug with its axis co-extensive with that of the blower. A straight conduit communicates between the intake of the blower and the exchanger, being co-axial with both of them. The heat exchanger is secured to the plug by a cylindrical housing while straight headers for the entry and the exit of the extraction fluid extend through the plug around the blower and are convected at one end, inside the housing, with the tubes of the heat exchanger circuit and at the other hand to an external utilization circuit. (IIB)

25044 METHOD OF COMPENSATING FOR VARIATIONS IN REACTIVITY OF A LIQUID MODERATED NUCLEAR REACTOR. (to Commissariat a l'Energie Atomique). French Patent 1,460,022. Oct. 17, 1966. Filed Oct. 13, 1965.

In order to compensate the reactivity changes due to fuel depletion and to poison build-up in a heavy-water moderated reactor, two different neutron poisons are dissolved in heavy water. Both poisons are associated in a soluble chemical compound and one of the poisons is removed by the purification circuit while the other poison is converted to a new soluble form. In this manner, compensation for fast reactivity decrease resulting from Xe poisoning takes place as if this latter were alone present by selectively eliminating one of the poisons (on ion exchange resius, for example) over a time interval which is varied as a function of Xe build-up in the reactor. The compensation for slow reactivity decrease (resulting from Sm poisoning and fission of nuclei) is effected by means of the second poison which is maintained in solution and removed (on ion exchange resius) over a time interval which is varied in dependence of the rate of the slow reactivity decrease. (I.I.B.)

25045 FUEL ELEMENTS FOR NUCLEAR REACTORS. (to Commissariat a l'Energie Atomique). Canadian Patent 778,889. Feb. 20, 1968. Priority date Aug. 16, 1962, France.

A fuel cluster consisting of several pencils made of sheathed stacks of UO_2 rings for use in a gas-cooled reactor is described. A nonfissile central rod and peripheral tie rods hold the fuel elements, thus forming a self contained unit. A system of "attachment grids" containing minute channels are joined to free spaces in the central rod and tie rods. The fuel pencils are attached at one end only. Excess pressure in the fuel elements is avoided because the fission gases can expand in the network of interconnected spaces. (F.S.A.)

25046 COOLING SYSTEM FOR NUCLEAR REACTOR. Bohdansky, Josef; Busse, Claus-Adolf; Grover, George Maurice (to European Atomic Energy Community). British Patent 1,108,499. Apr. 3, 1968. Priority date Dec. 14, 1964, Germany.

A description is given of a reactor having a heat pipe for the direct conversion of the nuclear heat to electrical energy. The fuel elements are thermally coupled to heat pipes; the condenser regions of the fuel heat pipes terminate in an emitter electrode of a thermionic converter. (M.L.S.)

25047 IMPROVED NUCLEAR REACTOR AND METHOD FOR REFUELING SAME. (to General Dynamics Corp.). British Patent 1,106,792. Mar. 20, 1968. Priority date Aug. 13, 1964, United States.

A reactor design is described which permits the use of a relatively short pressure vessel and an improved method for refueling. The pressure vessel, which is less than twice the length of the fuel elements, is fitted with a number of access openings with nozzles extending upward from the openings. The control rod drive mechanisms are disposed in the nozzles and are removed before refueling. The center fuel element in the zone under an access opening is removed by a fuel handling machine, and the peripheral elements in the zone are moved to the vacant central position and removed by the machine. (H.D.R.)

25048 IMPROVEMENTS IN NUCLEAR REACTORS. (to Societe Anglo-Belge Vulcain, Societe Anonyme). British Patent 1,109,925. Apr. 18, 1968. Priority date Dec. 4, 1964, Luxembourg.

The description of a pressurized-water reactor is presented. The reactor consists of a pressure vessel containing a core and a pressurizer. The fuel elements are suspended from the bottom plate of the pressurizer. The fuel element support system is made to two plates with provisions for coolant flow between the plates during refuelling. (D.C.C.)

25049 IMPROVEMENTS RELATING TO NUCLEAR REACTORS. Webb, John; Parker, Horace Frank (to United Kingdom Atomic Energy Authority). British Patent 1,108,915. Apr. 10, 1968. Filed July 10, 1964.

The description of a liquid lead-cooled fast reactor is presented. The reactor consists of an integral system of a liquid lead-cooled core and a water-steam heat exchange system. The heat transfer system is so designed that if lead coolant solidifies in the core, steam can be used to maintain liquid conditions. (D.C.C.)

25050 CONTROL ROD ACTUATING MECHANISM. Schoppen, Willibald (to Commissariat a l'Energie Atomique). British Patent 1,109,025. Apr. 10, 1968. Priority date Sept. 29, 1965, France.

The description of a control rod drive mechanism for a liquid metal-cooled hermetically sealed reactor is presented. The drive mechanism consists of a rod which penetrates the pressure vessel and connects to the control rod by gripping elements. The drive rod moves inside a coaxial tube which also penetrates the pressure vessel. The coaxial tube is hermetically sealed where it passes through the pressure vessel, and the drive rod is sealed to the coaxial tube. Apertures in the coaxial tube below the drive rod seal allow liquid metal-coolant to flow freely in the tube. (D.C.C.)

25051 IMPROVEMENTS RELATING TO NUCLEAR REACTORS. Challender, Ronald Scott; Hackney, Stanley; Barker, Kenneth; Hooper, Alan Thomas (to United Kingdom Atomic Energy Authority). British Patent 1,108,349. Apr. 3, 1968. Filed Oct. 8, 1965.

A method is given for reactor control which uses a variable vaporizable moderator liquid in predetermined zones in the reactor. Thermal neutron absorbers surround the moderator. The

variation in moderator is effected by a change of phase in moderator state. (M.L.S.)

25052 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS. Dent, Kenneth Henry (to United Kingdom Atomic Energy Authority). British Patent 1,109,101. Apr. 10, 1968. Filed Dec. 10, 1964.

A method of fuel element leak detection for gas-cooled reactors is described. This method consists of monitoring the outlet gas from the core; when excessive fission products are detected, the fission product detector is connected, manually, to individual fuel element coolant channels. The fission product detection instrumentation is described, also. (M.L.S.)

25053 A METHOD OF REMOVING CO_2 AND H_2O FROM A GAS STREAM. (to Brown Boverie/Krupp Reaktorbau GmbH). British Patent 1,105,985. Mar. 13, 1968. Priority date Aug. 17, 1965, Germany.

A method for removing carbon dioxide (CO_2) and water (H_2O) from a gas stream is described. Such a method involves use of absorbent filters made of lime; the filters are in segments which can be positioned in any desired location. This system is particularly applicable to gas-cooled reactors. (M.L.S.)

25054 IMPROVEMENTS IN AND RELATING TO NUCLEAR REACTORS. Saunders, Eric Lee; Lockney, Eric Victor (to Nuclear Power Plant Co., Ltd. AEI–John Thompson Nuclear Energy Co., Ltd.). British Patent 1,105,746. Mar. 13, 1968. Filed Sept. 9, 1964.

A core structure is described for gas-cooled graphite-moderated reactors in which a radiation shield is located between the moderator and a metal core-containing structure. The shield consists of a number of hollow walls formed of metal plates. The spaces between the walls are filled with a solid neutron moderating material, and coolant is circulated through the hollow walls. The shield is adapted to transmit lateral forces from the core to the core support structure. (H.D.R.)

25055 BLADED ROTARY BLOWERS. Allemann, Martin; Feer, Kurt (to Sulzer Brothers Ltd,). British Patent 1,107,992. Mar. 27, 1968. Priority date Apr. 8, 1964, Switzerland.

The description of a turboblower for a gas-cooled reactor is presented. The blower is mounted in the wall of a prestressed concrete containment vessel. The blower mount contains cooling regions which are supplied with coolant gas directly from the blower. (D.C.C.)

25056 IMPROVEMENTS IN AND RELATING TO NUCLEAR POWER PLANT. (to Sulzer Brothers Ltd,). British Patent 1,106,091. Mar. 13, 1968. Priority date Apr. 3, 1964, Switzerland.

The description of a nuclear reactor heat transfer system is presented. The heat transfer system consists of taking liquid coolant from the reactor and passing it through a heat exchanger to superheat a work medium. The superheated work medium passes through a turbine and then back into the reactor to become increasingly superheated. After passing through the reactor the work medium passes again through the heat exchanger to heat work medium and then to another turbine stage. A number of these heat exchanger sections can be arranged in parallel for maximum efficiency. The pressure levels of the heat exchange sections decrease from the first stage to the last stage. (D.C.C.)

25057 IMPROVEMENTS IN OR RELATING TO BLADED ROTARY BLOWERS. (to Sulzer Brothers Ltd,). British Patent 1,107,991. Mar. 27, 1968. Priority date Apr. 8, 1964, Switzerland.

The description of a turboblower for a gas-cooled reactor is presented. The seals and mounting configurations are described. The blower is mounted in the wall of a prestressed concrete containment vessel. The blower mount contains cooling regions which are supplied with coolant gas directly from the blower. (D.C.C.)

25058 FLUID SEALS. Baxter, Harry (to English Electric Co., Ltd.). British Patent 1,110,787. Apr. 24, 1968. Filed Oct. 2, 1964.

The description of a fluid seal for a gas-cooled reactor is presented. The seal consists of two circular rings with sealing blocks of graphite between them. The circular rings form a relationship of less than 180° with each other. The sealing blocks are arranged in an overlapping arrangement to allow for expansion under operating conditions while still retaining a tight seal. (D.C.C.)

Rocket and Space Reactors

Refer also to abstracts 23741 and 23885.

25059 (CONF-670445–, pp 18,25-32) SAFETY PROGRAM AT THE NUCLEAR ROCKET DEVELOPMENT STATION. Griffiths, Percy; Erickson, Peter B.; Parmenter, George L.; Wright, John M. (Space Nuclear Propulsion Office (AEC/NASA), Jackass Flats, Nev.). 8p.

The radiological safety program at NRDS directs itself toward the protection of personnel and the public from direct radiation and radioactive effluent associated with testing nuclear rocket engines. The cryogenics safety program directs itself to the prevention of accidents which could damage the test facilities and endanger associated personnel. Safety equipment and practices associated with each of the safety programs are discussed. (H.D.R.)

25060 (CONF-670445–, pp 18,55-63) NERVA DEVELOPMENT STATUS. Rice, C. M. (Aerojet-General Corp., Sacramento, Calif.); Esselman, W. H. (Westinghouse Electric Corp., Pittsburgh, Pa. Astronuclear Lab.). 10p.

Progress in the Nuclear Engine for Rocket Vehicle Applications Program, which is a part of Project ROVER, is summarized. The reactor and engine system are described, and their operating performance during the various test series is examined. (H.D.R.)

25061 (DLR-MITT-66-07) BERICHT UEBER DIE SITZUNG DES WGLR-FACHAUSSCHUSSES KERNENERGIE IN DER FLUGTECHNIK AM 8/9 DEZEMBER 1965 IN STUTTGART. (Report on the Session of the WGLR Professional Committee on Nuclear Energy in Flight Technology on December 8 and 9, 1965 in Stuttgart). (Wissenschaftliche Gesellschaft fuer Luft- und Raumfahrt e. V., Brunswick (West Germany)). June 30, 1966. 113p. (In German). (CONF-651221). Dep.

From Conference on Nuclear Energy in Flight Technology, Stuttgart, Germany.

Fourteen papers are included in which various aspects of the use of nuclear energy in flight technology are discussed. Individual abstracts were prepared for each of seven papers. (J.S.R.)

For abstracts of individual papers see: 23219, 23730, 24088, 24089, and 25062–25064.

25062 (DLR-MITT-66-07, pp 11-27) METALLHYDRID-MODERIERTE REAKTORSYSTEME ZUR ENERGIEVERSORGUNG VON RAUMFLUGKOERPERN. (Metal Hydride-Moderated Reactor Systems for Power Supplies for Space Flight Vehicles). Einfeld, K. (Internationale Atomreaktorbau G.m.b.H., Bensberg (West Germany)). (In German).

The characteristics of fast and thermal reactor systems for power sources in space vehicles are compared and contrasted. In order to obtain a low total weight for the reactor system comprising the reactor, convertor, and emitter, the highest possible reactor temperatures are desired. This leads to the application of metal hydride, the best known of which is Zr hydride. The characteristics of homogeneous Zr hydride systems are compared with those of Yb hydride systems. A Zr hydride moderator in which the heat is transported by heat pipes from the core is illustrated. Typical convertor systems that can be used in space flight are illustrated. A circuit diagram of a purely thermoelectric power supply system using Zr hydride is presented. The discussion reveals that for power below 100 Kwe metal hydride-moderated liquid metal-cooled reactors represent the optimum solution and are suitable for all convertor systems considered. (J.S.R.)

25063 (DLR-MITT-66-07, pp 87-99) AN EVALUATION OF FAST REACTOR POWER PLANTS FOR SPACE APPLICATIONS. Balz, W.; Giacomazzi, G.; Zanantoni, C. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center).

The description of an optimum performance nuclear power plant of 1 MW(e) output for space applications is presented. The reactor design considered is a fast reactor with Li primary coolant and UC fuel. (D.C.C.)

25064 (DLR-MITT-66-07, pp 101-10) NUKLEARE ABSCHIRMUNG UND DARAUS RESULTIERENDE GESICHTSPUNKTE FUER DIE GESAMTANLAGE DES TRIKT 50. (Nuclear Shielding and the Resulting Aspects for the Overall Plan of the TRIKT 50). Hehn, G. (Technische Hochschule, Stuttgart (West Germany). Institut fuer Kernenergetik). (In German).

The reactor shielding of the TRIKT 50 is illustrated and described in detail. The requirements placed on the other components of the installation so that the shielding can have a minimum weight are discussed. The payload was evaluated since the permissible radiation dose of the payload determines the shielding thickness. (J.S.R.)

25065 (LA-DC-9412) FISSION DISTRIBUTION TECHNIQUES FOR ROVER REACTORS. Helmick, Herbert H.; Orndoff, John D.

(Los Alamos Scientific Lab., N. Mex.). [nd]. Contract W-7405-eng-36. 4p. (CONF-680601-7). Dep. CFSTI.

From 14th Annual Meeting of the American Nuclear Society, Toronto, Ontario.

The technique used to obtain thousands of sampling measurements of fission distribution in a Rover reactor is described. A plot of the ratio of two fission distributions measured in the Phoebus 2A reactor is presented. One distribution was made with the reactor control drums rotated out 115° from full shutdown and the second profile had the drums at 95°. (D.C.C.)

25066 DISTRIBUTED PARAMETER OPTIMUM CONTROL OF A NUCLEAR ROCKET WITH THERMAL STRESS CONSTRAINTS. Briggs, David Lawrence. Troy, N. Y., Rensselaer Polytechnic Inst., 1967. 115p.

Thesis.

The problem considered is that of programming minimum time, coolant flow transients through a nuclear rocket such that temperature gradients in the fuel elements, and the corresponding thermal stresses produced, do not exceed tolerable values. A distributed parameter thermal and stress model is used for the solid fuel element nuclear rocket. The problem is formulated as a distributed parameter optimal control problem. The initial conditions are taken as steady state, and the terminal condition that the coolant flow obtain a fixed higher level may be interpreted as an inequality condition on the terminal states. By using the system step response and by examining the coupling between state and control level in a bilinear system, the form of the optimal control program for the case of constant reactor power level is deduced. For reactor power level a function of space, the solution is obtained by discretizing in the space dimension to give an arbitrary order set of ordinary differential, system equations. Some general discussion for the constrained optimization problem is given, especially as to the complication of the inequality constraint. Based on the result that the optimal control is a nonswitching, boundary control, a non-iterative algorithm is constructed to compute the optimal control program. The migration of the axial position of the maximum stress in the fuel elements is accounted for in the algorithm. The algorithm was programmed on a digital computer and numerical results are given for the optimal flow program and the resulting stress distribution for various cases. (Disser. Abstr.)

25067 HIGH TEMPERATURE NUCLEAR FUEL ELEMENTS. Thomas, Donald E. (to Westinghouse Electric Corp.). U. S. Patent 3,347,750. Oct. 17, 1967. Filed Nov. 16, 1965.

The description of a nuclear reactor fuel element is presented. The fuel element consists of pellets in an end-to-end arrangement inside a cylindrical cladding. The pellets are of less diameter than the cladding diameter to allow expansion and contraction during operation. The fuel pellets consist of 5 to 90 mol percent UC with the balance consisting of HfC. Other combinations of pellet composition consist of UC, NbC–UC, NbC–TaC–UC, TiC–UC, UC–ZrC, TiC–UC–WC, and MoC–UC–ZrC. (D.C.C.)

25068 IMPROVEMENTS IN OR RELATING TO GAS-FILLED DISCHARGE TUBES. (to CSF-Compagnie Generale De Telegraphie Sans Fil). British Patent 1,106,347. Mar. 13, 1968. Priority date July 16, 1964, France.

A description is given of an electric generator for conversion of nuclear heat into electrical energy. The gas-filled discharge tubes, which comprise the direct current generator, are characterized by cathode and anode materials. A generator of this type is particularly useful for space applications. (M.L.S.)

25069 NUCLEAR REACTOR ADAPTED FOR USE IN SPACE. Roberts, John J.; Croke, Edward J. (to United States Atomic Energy Commission). U. S. Patent 3,378,449. Apr. 16, 1968.

A nuclear reactor for use in space incorporating PuP as fuel, heat pipes employing Li as working fluid to conduct the heat developed in the fuel to thermoelements, and heat pipes employing K as working fluid for rejecting waste heat to space is described. (AEC)

25070 NUCLEAR REACTOR FOR USE IN SPACE. Hanthorn, Howard E.; Harty, Harold (to United States Atomic Energy Commission). U. S. Patent 3,377,251. Apr. 9, 1968.

A nuclear reactor incorporating a molten Pu alloy as fuel and liquid Na as coolant designed primarily for use in a low-gravity environment is described. Centrifugal force created by rotation of the reactor causes drops of the fuel alloy to flow outwardly from the core through the Na coolant. The reactor is controlled by varying the rate of rotation of the reactor and the rate of return of the fuel to the core. (AEC)

25071 CAPABILITY REQUIREMENTS FOR NUCLEAR SPACE SYSTEMS. Report of the Ad Hoc Committee on the Nuclear Space Program. New York, Atomic Industrial Forum, Inc., 1966. 23p. $4.00.

A review of programs presently being carried out and an analysis of programs required for future demands are presented. A description of isotopic power systems and reactor power systems is presented. Nuclear rocket propulsion systems and electric propulsion systems are described. (D.C.C.)

Process Heat and Desalination Reactors

25072 NUCLEAR-POWER SEA-WATER CONVERSION PLANT. (to United States Atomic Energy Commission). British Patent 1,106,488. Mar. 20, 1968. Priority date July 19, 1965, United States.

A water desalination plant is described which couples a water-cooled nuclear reactor to a flash distillation plant. The reactor is located at the bottom of a deep pit filled with demineralized water coolant. Coolant is circulated through the reactor core at a rate such that the depth of water in the reservoir above the reactor is sufficient to prevent boiling. The coolant passes from the core through brine heaters and re-enters the coolant reservoir near the top. The plant design eliminates the possibility of a complete loss-of-coolant accident and subsequent fission product release, even if the coolant reservoir walls were ruptured by a major earthquake. (H.D.R.)

25073 IRON ORE REDUCING PROCESS AND APPARATUS, USING NUCLEAR HEAT. Schenck, Hermann. British Patent 1,109,652. Apr. 10, 1968. Priority date May 25, 1965, Germany.

A process for the utilization of discharge heat produced by reactors is described. The discharge heat is to be used for the reduction of iron ore, thereby allowing both economic production of large amounts of electricity and utilization of waste heat. The discharge heat is transferred to the iron ore, which is contained in a reduction vessel, by means of a secondary, or intermediate, heat exchanger. A special iron ore reducing process is described which ensures reduction at the 500°–700°C reactor coolant temperature. (M.L.S.)

Research and Test Reactors and Critical Assemblies

Refer also to abstracts 23192, 23762, 23843, 23844, 23859, 24821, 24858, and 24991.

25074 (AAEC/TM–411) HEAVY WATER REACTOR CHEMISTRY STUDIES. PART 3. ROLE OF CARBON DIOXIDE. Ryan, H. F.; Smythe, L. E. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Oct. 1967. 19p. Dep.

The mechanism of the adsorption of bicarbonate ions on both unirradiated and irradiated Amberlite XE-78 resin in the OH-form was studied using ^{14}C tracer techniques. The data obtained from these laboratory experiments were related to reactor conditions in HIFAR. The mechanism of adsorption of dissolved carbon dioxide and other anionic impurities from the HIFAR moderator on the anion exchange resin is now understood. (auth)

25075 (APDA–201) CROSS SECTION EVALUATION AND CRITICAL EXPERIMENT ANALYSIS FOR FAST REACTORS. Pitterle, T. A.; Yamamoto, M. (Atomic Power Development Associates, Inc., Detroit, Mich.). June 1967. 101p. Dep.

For Edison Electric Inst., New York.

A neutron cross section evaluation and critical experiment analysis conducted in support of PuO_2 core studies for the Enrico Fermi Reactor are presented. Cross sections of primary importance for fast reactor analysis were evaluated for use with the Argonne National Laboratory (ANL) MC^2 code which generates multigroup data from basic cross section data. The resulting multigroup cross sections were used for diffusion theory calculations of ZPR-III Assemblies 47 and 48. A comparison of calculation with experiment is presented for these critical experiments. (auth)

25076 (BNWL–599) FTR FUEL DESIGN AND ANALYSIS HYDRAULIC, SODIUM, AND MECHANICAL TESTING. Cohn, P. D. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Mar. 1968. Contract AT(45-1)-1830. 53p. Dep. CFSTI.

The plan for water flow, sodium flow, and mechanical testing of FTR driver fuel pins, bundles, and subassemblies is presented. Mechanical effects of vibration, fretting corrosion, and fretting fatigue coupled with the vibration and material removal measurements noted in hydraulic and the Na dynamic tests are analyzed. The thermal-hydraulic development studies examine aberrated pin bundles, variable spacing, variable spacer geometry, and differences between compliant grid spacers and the reference wire wrap spacers. Vessel hydraulic mockup studies for flow distribution analysis are described. (auth)

25077 (BNWL-683) FAST FLUX TEST FACILITY. EVALUATION OF CONCEPTUAL FEATURES FOR THE REACTOR REFUELING SYSTEM. Nash, C. R.; Peckinpaugh, C. L. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Mar. 1968. Contract AT(45-1)-1830. 37p. Dep. CFSTI.

The evaluation effort for selecting a reactor refueling concept for the FFTF is described. Different methods of fuel handling are investigated with reference to safety, economics, flexibility and versatility, interfacing system compatibility, and experiment handling requirements. (D.C.C.)

25078 (CEA-R-3367) EXPERIENCES DE CRITICITE REALISEES AVEC UNE SOLUTION HOMOGENE DE PLUTONIUM. RESULTATS EXPERIMENTAUX. INTERPRETATIONS THEORIQUES. (Critical Experiments Carried Out with a Homogeneous Plutonium Solution. Experimental Results. Theoretical Interpretations). Bouly, Jean Claude; Caizergues, Robert; Deilgat, Edouard; Houelle, Michel; Lecorche, Pierre (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Dec. 1967. 90p. (In French). Dep.

Results of a series of experimental and theoretical criticality studies on plutonium are given. A comparison of theoretical and experimental values for critical heights of solutions is made; effects of nitrogen, introduced in the form of the nitrate ion, on the reactivity of the fissile media are evaluated; the effects of ^{240}Pu on the reactivity of the media are analyzed. Influence of moderators which are introduced into the solution is investigated; effects of dimensions of the inner cavity of annular cylinders are analyzed. (auth)

25079 (DOCKET-5062-1) TWO MEGAWATT OPERATION OF THE UNIVERSITY OF VIRGINIA REACTOR. Safety Analysis Report. Amendment to License R-66. (Virginia Univ., Charlottesville. School of Engineering and Applied Science). Aug. 22, 1967. 245p. (UVAR-17). Dep. CFSTI.

An increase in maximum licensed power level is requested. Information related to this request is given under the following broad topics: reactor site, facility changes since 1960, administrative procedures, thermal-hydraulic safety analysis, radiation hazards, and technical specifications. Calculation of Argon-41 concentrations for the UVAR is detailed; dose calculations for a maximum credible accident are given. The report "A Study of the Shield of the University of Virginia Nuclear Research Reactor-ORNL-TM-662" is included. (M.L.S.)

25080 (DOCKET-5062-2) THE UNIVERSITY OF VIRGINIA REACTOR. Description and Operation. [Preliminary Safety Analysis Report], Amendment 2. (Virginia Univ., Charlottesville. School of Engineering). Dec. 4, 1959. 15p. (UVAR-8(Amend. 2)). Dep. CFSTI.

Information on environmental monitoring and weather instrumentation for the University of Virginia reactor is given. (M.L.S.)

25081 (DOCKET-5062-3) THE UNIVERSITY OF VIRGINIA REACTOR. Description and Operation. [Preliminary Safety Analysis Report], Amendment 3. (Virginia Univ., Charlottesville. School of Engineering). Feb. 5, 1960. 3p. (UVAR-8(Amend. 3)). Dep. CFSTI.

A change of limits on activity of gaseous effluent is given. (M.L.S.)

25082 (DP-1122) LATTICE EXPERIMENTS WITH SIMULATED BURNED-UP FUEL FOR D_2O POWER REACTORS. Baumann, N. P.; Crandall, J. L.; Olson, R. L.; O'Neill, G. F.; Pellarin, D. J.; Vandervelde, V. D. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). Feb. 1968. Contract AT(07-2)-1. 75p. Dep. CFSTI.

The changes in lattice physics parameters accompanying fuel burnup in natural-uranium-fueled D_2O power reactors were studied by measuring bucklings and neutron reaction rates for D_2O-moderated lattices of UO_2 rod clusters containing five different concentrations of ^{235}U and the plutonium isotopes. Both 19- and 31-rod clusters with D_2O, gas, and organic coolants were used at triangular lattice pitches of 9.33 and 12.12 inches. Substitution measurements in natural UO_2 lattices in the Process Development Pile determined the uniform lattice bucklings. Exponential measurements in the Subcritical Experiment determined the changes in buckling induced by uniform lattice heating. Foil activations, also performed in the Subcritical Experiment, measured the thermal neutron distributions in terms of Mn activations, the thermal neutron spectral indices in terms of Lu-Mn and ^{239}Pu-^{235}U activations, resonance neutron capture in ^{238}U in terms of the cadmium ratio for ^{239}Np production, fast fissions in ^{238}U and all fissions in ^{235}U in terms of the induced fission product activities, and fissile material conversion ratios in terms of the ^{238}U capture to ^{235}U fission ratios. These results were compared with calculations by the HAMMER code, a one-dimensional, integral-transport cell calculation performed in 84 energy groups. Although agreement between experiment and theory was in general good, significant discrepancies were observed in the spectral index and resonance capture calculations. These discrepancies were tentatively assigned primarily to difficulties in reducing the highly heterogeneous fuel clusters into a ring model for the one-dimensional calculations. (auth)

25083 (GEAP-5541) SODIUM-COOLED REACTORS FAST CERAMIC REACTOR DEVELOPMENT PROGRAM. Twenty-Fourth Quarterly Report, August-October 1967. (General Electric Co., Sunnyvale, Calif. Advanced Products Operation). Dec. 1967. Contract AT(04-3)-189. 135p. Dep. CFSTI.

REACTOR FUEL ELEMENTS — burnup analysis of NaK-cooled type-316 and type-347 stainless steel clad plutonium oxide (PuO_2)-uranium oxide (UO_2); safety of, plutonium oxide (PuO_2)-uranium oxide (UO_2) analysis of effects of molten fuel movement on; swelling of stainless steel clad plutonium oxide (PuO_2)-uranium oxide (UO_2), effects of burnup on; failure of Incoloy 800 and Hastelloy clad plutonium oxide (PuO_2)-uranium oxide (UO_2), analysis of; cycle management of sodium-cooled plutonium oxide (PuO_2)-uranium oxide (UO_2), economics of; vibrations in sodium-cooled, analysis of

FISSION PRODUCTS — measurement in irradiated type-316 and type-347 stainless steel clad plutonium oxide (PuO_2)-uranium oxide (UO_2) fuel rods

SODIUM ALLOYS AND SYSTEMS — K-Na, effects on burnup of type-316 and type-347 stainless steel clad plutonium oxide (PuO_2)-uranium oxide (UO_2) fuel rods, analysis of

PLUTONIUM OXIDES PuO_2 — PuO_2-UO_2, burnup analysis of NaK-cooled type-316 and type-347 stainless steel clad fuel rods of

STAINLESS STEEL — corrosive effects of NaK on plutonium oxide (PuO_2)-uranium oxide (UO_2) fuel rods clad with type-316 and type-347, analysis of; radiation effects on swelling of types-304, -321, -343, and -316L, neutron; radiation effects on tensile properties of types-304, -316, -321, and -347, neutron

GENERAL ELECTRIC TEST REACTOR — fuel pin irradiation studies during August to October 1967 in, analysis of

REACTOR EXPERIMENTAL FACILITIES — description of NaK environment, for irradiation of stainless steel clad plutonium oxide (PuO_2)-uranium oxide (UO_2) fuel pins

EXPERIMENTAL BREEDER REACTOR-II — fuel pin irradiation studies during August to October 1967 in, analysis of,

HEAT TRANSFER SYSTEMS — coolant-loss-accidents in liquid sodium, testing of effects of flow on

HASTELLOY — cladding for plutonium oxide (PuO_2)-uranium oxide (UO_2) fuel elements, analysis of failure of

INCOLOY 800 — radiation effects on swelling of, neutron; radiation effects on tensile properties of, neutron; cladding for plutonium oxide (PuO_2)-uranium oxide (UO_2) fuel elements, analysis of failure of

SODIUM — coolant flow of, effects on fuel temperature of loss of

VIBRATION TESTING — fuel element, analysis of sodium flow induced

NEUTRONS — radiation effects on Incoloy 800 and stainless steel cladding materials

TENSILE PROPERTIES — measurement of neutron irradiated Incoloy 800 and stainless steels

URANIUM OXIDES UO_2 — PuO_2-UO_2, fuel cladding failure on, analysis of Incoloy 800 and Hastelloy; PuO_2-UO_2, cycle management of sodium-cooled fuel rods of, economics of (D.C.C.)

25084 (IEA-128) UTILIZACAO DO DOMPUTADOR IBM 1620 PARA ESTIMATIVAS DA CURVATURA MATERIAL DE ARRANJOS MULTIPLICADORES. (Use of the IBM 1620 Computer for Estimation of Buckling in Critical Assemblies). Franzen, H. R.; Mazzilli, Elenice (Instituto de Energia Atomica, Sao Paulo (Brazil)). Nov. 1966. 33p. (In Portuguese). Dep.

The FRAMA program, developed for the IBM 1620, model II, permits the evaluation of material bucklings of UO_2 lattices moderated by D_2O-H_2O mixtures. Material buckling values are given for 15 lattices of slightly enriched, Type 304 stainless steel-clad UO_2 fuel with D_2O-H_2O concentrations of 99.4, 81.0, and 55.0%.

The FORTRAN list, input-output data, flow chart, and a numerical example are presented. (TSS) (auth)

25085 (IEA-133) EXPERIMENTAL FACILITY FOR THE PRODUCTION OF REACTOR NEUTRON CAPTURE GAMMA RAYS. Mafra, Olga Y.; Suarez, Achilles A. (Instituto de Energia Atomica, Sao Paulo (Brazil)). Dec. 1966. 25p. Dep.

The facility at the IEAR-1 swimming pool reactor for gamma production by neutron capture is described. Data are presented on the targets used to cover the gamma energy range from 4 to 10 MeV. (W.H.K.)

25086 (IEA-139) PROGRESSIVE SUBSTITUTION EXPERIMENTS IN UO_2 LATTICES MODERATED BY D_2O–H_2O MIXTURES. Franzen, H. R. (Instituto de Energia Atomica, Sao Paulo (Brazil)). Apr. 1967. 30p. Dep.

Buckling measurements for cores of uranium oxide (3.00% enriched in ^{235}U) in different mixtures of D_2O/H_2O were performed in the NORA reactor by means of a progressive substitution technique. In order to check the results, some experiments were also carried out by the substitution technique in critical lattices for which the buckling was already known. Some subcritical experiments were also performed to give additional information about the buckling obtained by substitution experiments. The analysis was done by three regions, two group theory and a correction was introduced in order to take into account the effect of the reflector. For a D_2O concentration of 99.50% and a lattice pitch of 6.544 cm, the material buckling with void was obtained by three regions, one group theory. All the results were found to agree satisfactorily with the results from critical experiments. (auth)

25087 (INR-P-853/IXA/PR) THE NEUTRON DIFFUSION PARAMETER MEASUREMENTS IN GRAPHITE OF THE ANNA REACTOR. Chwaszczewski, S.; Mikulski, A. T.; Dybowski, K. (Institute of Nuclear Research, Warsaw (Poland)). 1967. 23p. Dep.

Measurements of the parameters $\langle \Sigma_\alpha \vartheta \rangle$ and D were made in the graphite of the ANNA reactor by the pulsed neutron source method and based on the determination of the decay constant for few space dependent distributions of higher harmonics. The results, $\langle \Sigma_\alpha \vartheta \rangle = 79 \pm 3$ per sec and $D = (211 \pm 5) \times 10^3$ cm^2/sec for $\rho = 1.7$ g/cm^3 and temperature of $20 \pm 4°C$, are in good agreement with previous measurements, and confirm that the ANNA graphite meets the generally accepted standards of nuclear grade graphite. (TSS) (auth)

25088 (KAPL-P-3171) POWER CYCLING FOR IRRADIATION SPECIMENS. Johnson, R. M.; Cornell, D. H.; Myers, R. L. (Knolls Atomic Power Lab., Schenectady, N. Y.). Sept. 28, 1966. Contract W-31-109-eng-52. 16p. Dep. CFSTI.

A detailed description of the Cycle Test Facility for simulating various reactor transient conditions is presented. The assembly is capable of precisely repositioning the irradiation test specimens throughout the available loop flux range at various controlled rates while the reactor is at full power. Design drawings are included. (D.C.C.)

25089 (LA-DC-8521) MINIMUM CRITICAL MASS. Jarvis, George A.; Mills, Carroll B. (Los Alamos Scientific Lab., N. Mex.). [nd]. Contract W-7405-eng-36. 10p. Dep. CFSTI.

A cubical core of enriched (93.15%) ^{235}U foil in a cubical Be reflector was used to establish minimum critical mass measurements. Three core sizes, of bases approximately 8 in., 6.5 in., and 6 in. square, were made critical by adjusting core height. Results of the experimental study are presented. (D.C.C.)

25090 (LA-DC-9025) ISOTHERMAL IRRADIATION ASSEMBLY FOR STUDY OF FAST NEUTRON DAMAGE TO CERAMICS. Ranken, W. A.; Summers, C. S. (Los Alamos Scientific Lab., N. Mex.). [1966]. Contract W-7405-eng-36. 5p. (CONF-671045-5). Dep. CFSTI.

From IEEE Thermionic Conversion Specialist Conference, Palo Alto, Calif.

Knowledge of the effect of fast neutron irradiation on the electrical, thermal and mechanical behavior of the ceramic and the bonded ceramic-metal components required for thermionic fuel rod construction is as yet very limited in extent. The EBR-II is a desirable facility for obtaining such data since its neutron spectrum is similar to that occurring in most thermionic reactor designs and the extrinsic testing cost is low. However, this facility has the disadvantage that temperature control and measurement must be accomplished without physical connections to the exterior of the reactor vessel. Therefore it has been necessary to develop irradiation assemblies in which the sample temperature can be preset and maintained to within 15°C despite inaccurate knowledge of gamma ray heat generation rates in the testing region. These isothermal irradiation unit designs feature gas-filled stainless steel heat pipes with sodium working fluid. Operating temperature is established by the amount of gas initially introduced into the heat pipes. Results of testing the assemblies both in the laboratory and in the Omega West Reactor are given. (auth)

25091 (LA-DC-9413) LIQUID JET SUPER FLUX REACTOR (LJSFR). King, L. D. P. (Los Alamos Scientific Lab., N. Mex.). [1967]. Contract W-7405-eng-36. 3p. Dep. CFSTI.

The description of a Liquid Jet Super Flux Reactor (LJSFR) is presented. The LJSFR is designed similar to the operation of a flame or jet engine except that neutrons replace the normal flame propagation front and no oxidizer is required to burn the uranium supplied by the liquid fuel. Advantages of the system are listed. (D.C.C.)

25092 (LA-DC-9425) USE OF SLOW TRANSIENT EXPERIMENTS TO EVALUATE FUEL TEMPERATURE COEFFICIENTS IN REACTORS. Vigil, J. C. (Los Alamos Scientific Lab., N. Mex.). [1967]. Contract W-7405-eng-36. 4p. (CONF-680601-15). Dep. CFSTI.

From 14th Annual Meeting of the American Nuclear Society, Toronto, Ontario.

Numerical calculations of the fuel temperature coefficient in UHTREX are presented. The series of slow transients for verifying the calculated results are performed using the ANCON code. (D.C.C.)

25093 (LA-DC-9427) COMPARISON OF POWER PROFILE CALCULATIONS WITH EXPERIMENT IN UHTREX. Meem, J. L.; Vigil, J. C. (Los Alamos Scientific Lab., N. Mex.). [1967]. Contract W-7405-eng-36. 6p. (CONF-680601-11). Dep. CFSTI.

From 14th Annual Meeting of the American Nuclear Society, Toronto, Ontario.

One- and two-dimensional S_n transport calculations of the power profile or flux distribution in the Ultra High Temperature Reactor Experiment are compared with measurements made both in the cold-critical experiment, UCX-1, and in the fully assembled reactor, UCX-2. (H.D.R.)

25094 (LA-DC-9511) CALCULATED AND EXPERIMENTAL FLUX AND POWER DISTRIBUTIONS IN UHTREX. Vigil, J. C.; LaBauve, R. J.; Meem, J. L. (Los Alamos Scientific Lab., N. Mex.). [1967]. Contract W-7405-eng-36. 4p. (CONF-680601-14). Dep. CFSTI.

From 14th Annual Meeting of the American Nuclear Society, Toronto, Ontario.

One- and two-dimensional S_n transport calculations of neutron flux and power distributions in the Ultra High Temperature Reactor Experiment are compared with experimental results. (H.D.R.)

25095 (ORNL-TM-1737) THE LOW-INTENSITY TESTING REACTOR: A FUNCTIONAL DESCRIPTION. Cagle, C. D.; Casto, W. R. (Oak Ridge National Lab., Tenn.). [nd]. Contract W-7405-eng-26. 258p. Dep. CFSTI.

A description of the LITR is presented. Topics presented in the description include: siting; construction and fabrication; reactor safety; containment, cell ventillation, and off-gas; reactor components and experimental facilities; reactor cooling system; core physics, nuclear design, and heat transfer; fuel element design; reactor instrumentation and controls; shielding; water-disposal systems; and administrative organization. (D.C.C.)

25096 (ORNL-TM-2144) APPLICATION OF GAMMA-RAY DETECTION FOR REACTOR DIAGNOSIS. Roux, D. P.; Fry, D. N.; Robinson, J. C. (Oak Ridge National Lab., Tenn.). Mar. 20, 1968. Contract W-7405-eng-26. 17p. Dep. CFSTI.

Power spectral density (PSD) measurements of the fluctuating current from a gamma-sensitive and a neutron-sensitive ionization chamber are compared as a reactor diagnostic tool in the HFIR operating at power. An analytical model is presented to demonstrate that, when both observed gamma and neutron PSD are normalized by the square of the prompt mean current of the chambers, they yield the same absolute PSD. The analytical result is verified experimentally with a multisection ionization chamber, composed of electrically independent closely located neutron-sensitive and gamma-sensitive chambers. In the case of the gamma chamber, an estimate of the current component caused by the delayed photons emitted by the radioactive fission products is necessary to measure the absolute PSD. In this experiment the "delayed" current component has been estimated to be 13% of the total gamma current. (auth)

25097 (ORNL-TM-2158) BULK SHIELDING FACILITY QUARTERLY REPORT, OCTOBER–DECEMBER OF 1967. Tabor, W. H. (comp.) (Oak Ridge National Lab., Tenn.). Feb. 28, 1968. Contract W-7405-eng-26. 25p. Dep. CFSTI.

The BSR was operated for 382.0 hr and produced 682,958 kwh of energy. The major portion of this operation was for basic research. The PCA was operated for three days to check new dual-section ionization chambers. (auth)

25098 (ORNL-TM-2164) ORNL NUCLEAR SAFETY RESEARCH AND DEVELOPMENT PROGRAM. Bimonthly Report, January–February 1968. Cottrell, Wm. B. (Oak Ridge National Lab., Tenn.). Mar. 26, 1968. Contract W-7405-eng-26. 144p. Dep. CFSTI.

Included are work on various chemical reactions, as well as the release, characterization, and transport of fission products in containment systems under various accident conditions and on problems associated with the removal of these fission products from gas streams. Although most of this work is in general support of water-cooled power reactor technology, including LOFT and CSE programs, the work reflects the current safety problems, such as measurements of the prompt-release phenomena and the efficacy of containment spray and pool-suppression systems for fission-product removal. Several projects are also conducted in support of other reactor types, including both molten-salt breeder reactors and the high-temperature gas-cooled reactor (HTGR). Other major projects include fuel-transport safety investigations, a series of discussion papers on various aspects of water-reactor technology, antiseismic design of nuclear facilities and studies of piping and pressure-vessel technology. Experimental work relative to pressure-vessel technology includes investigations of the attachment of nozzles to shells and the implementation of joint AEC-PVRC programs on heavy-section steel technology and nuclear piping, pumps, and valves. Several of the projects are directly related to another major undertaking, namely, the AEC's standards program, which entails development of engineering safeguards and the establishment of codes and standards for government-owned or -sponsored reactor facilities. Another task, CHORD-S, is concerned with the establishment of computer programs for the evaluation of reactor design data. The recent activities of NSIC and the Nuclear Safety Journal in behalf of the nuclear community are also discussed. (auth)

25099 (SRRC-24/68) UPGRADING POWER OF THE SCOTTISH UNIVERSITIES RESEARCH REACTOR. PART 1. ANALYSIS OF REACTOR COOLING SYSTEM. Riley, J. A. (Scottish Research Reactor Centre, East Kilbride (Scotland)). [1967]. 20p. Dep.

A theoretical analysis of the cooling system of the U.T.R.-100 is presented. The resulting equations give the limiting temperatures as functions of the primary and secondary coolant flow rates, plant characteristics, the reactor power, and the ambient air temperature. It is pointed out that an experimental program of work must be undertaken to determine the required plant characteristics. Only after these characteristics have been obtained will it be possible to predict accurately the maximum allowable reactor power and how this power varies with changes in primary and secondary coolant flow rates. (auth)

25100 THERMAL NEUTRON FLUX DISTRIBUTION AND FLUX TRAP EFFECT IN THE ACTIVE CORE OF THE UA-RR-1 REACTOR. Saad, E. A. (Atomic Energy Establishment, Cairo); Eissa, N. A.; Bartchouk, I.; El-Mofty, O. H. Acta Phys. Acad. Sci. Hung., 23: 327-40(1967).

The thermal neutron flux distribution at various points of the active core and irradiation channels of the UAR reactor was measured by the neutron activation method of copper and gold foils. An increase in the thermal neutron flux in the active core was achieved by creating a water cavity of 7 cm^3 section. The thermal neutron flux in the cavity was increased 2.3 and 2.6 times compared with that in the active core and the irradiation channels, respectively. 13 references. (auth)

25101 SPECTRA OF THE GAMMA-RAYS FROM THE SPECIALIZED CHANNELS OF THE IRT-1000 REACTOR IN SOFIA. Dragnev, Tencho; Yaneva, Nataliya; Pancheva, Nedyalka. Izv. Fiz. Inst. Aneb, Bulg. Akad. Nauk., 16: 143-7(1967). (In Bulgarian).

Using a scintillation spectrometer and the SA-40B analyzer, measurements were taken of the energy spectra of the gamma-irradiation of the IRT-1000 reactor in Sofia —the channel for obtaining beams of fast neutrons, the channel for obtaining thermal neutrons (thermal column), and the gamma channel for obtaining beams of almost mono-energy gamma rays with energies of 3 to 11 MeV. The spectra obtained from the gamma channel indicate that the system of collimators and filters used provides for the effective extraction of the gamma beams from the entrainment of the thermal neutrons by the nuclei of the target, under a minimum background of gamma irradiation, and the thermal neutrons of the active zone of the reactor. The spectra of the gamma radiation from the channel of the rapid neutrons and the thermal column will help in the more precise determination of the dose of gamma radiation absorbed by the neutron-irradiated specimens. (auth)

25102 ^{131}I DETERMINATION IN THE GASEOUS ATMOSPHERE OF THE L54M REACTOR. Kaftal, S.; Sangiust, V.; Terrani, S. (Politecnico, Milan). Energ. Nucl. (Milan), 15: 268-71(Apr. 1968).

The activity of the fission ^{131}I in the gaseous atmosphere of the L54M homogeneous solution reactor's primary circuit has been measured. Two experiments have been performed: stopping first the recombiner pump and then the reactor, and shutting down the reactor and after 1 minute the pump. In the first case, which approaches the worst conditions for an accident, a ratio of $3 \cdot 10^{-5}$ between the free ^{131}I and the produced ^{131}I was found; in the second case the ratio was $0.5 \cdot 10^{-6}$. (auth)

25103 ABSORPTION CROSS-SECTION MEASUREMENTS BY MEANS OF THE PILE OSCILLATOR TECHNIQUE IN THE RB-2 REACTOR. Benedetti, F.; Brighenti, G.; Chiodi, P. L. (SNAM, Milan, Univ., Bologna). Energ. Nucl. (Milan), 15: 255-60(Apr. 1968). (In Italian).

The pile oscillator technique has been used for absorption cross-section measurements of samples in RB-2 reactor. The design criteria and characteristics of the experimental devices used are described as well as the system performance and the results of measurements carried out on some materials. (auth)

25104 EFFECTIVE FRACTION OF DELAYED NEUTRONS OF A HOMOGENEOUS URANIUM–AQUEOUS ACTIVE ZONE. Levadnyi, V. A. (Inst. of Nuclear Power, Minsk). Vestsi Akad. Navuk BSSR, Ser. Fiz.-Tekh. Navuk, No. 4, 13-17(1967). (In Russian).

The methodics and the results of the measurement of the effective fraction of the delayed neutrons of a uranium–water lattice with the ratio of the hydrogen nuclei to ^{235}U nuclei varying from 230 to 660 are described. The fuel of the action zone was replaced with boron absorbers, for which the macroscopic absorption cross section for thermal neutrons agrees with the macroscopic absorption cross section of the fuel. The change of the relativity of the critical active zone, cylindrically shaped was determined by the change of the axial material parameters. The total change of reactivity of the reactor during replacement of all fuel of the active zone, in accordance with perturbation theory, is equal to 1. Since the reactivity in the experiment is determined in the fraction of comparative values of delayed neutrons, γ, then the significance of the comparative values of the delayed neutrons appears. The effective fraction of the delayed neutrons was calculated as $\beta_{eff} = \gamma\beta$, where $\beta = 0.0064 \pm 0.0002$. The calculated effective fraction of delayed neutrons of the lattice studied agreed well with the experimental data. (tr-auth)

25105 MEASURING THE GEOMETRICAL DIMENSIONS OF HOMOGENEOUS URANIUM-WATER REACTOR CORES HAVING SMALL-SCALE HETEROGENEITIES. Kontrovskii, S. N.; Levadnyi, V. A.; Yaroshevich, O. I. (Inst. of Nuclear Power Engineering, Minsk). Vestsi Akad. Navuk BSSR, Ser. Fiz.-Tekh. Navuk, No. 3, 32-7(1967). (In Russian).

The critical dimensions of a reactor, and the effective addition of reflector can be determined by making reactivity measurements on subcritical assemblies, and by noting a number of critical states of the active core at various settings of the control rods. These methods were found to be accurate ~2% for relatively small homogeneous cores. The effective addition of reflector and geometric size as measured by the first method was less accurate than that measured by the second method. The values obtained by both methods coincided within the limits of the experimental errors. The method of measuring neutron flux distribution was not applicable in this case. (TTT)

25106 EXPONENTIELE EN KRITISCHE EXPERIMENTEN EN RESEARCHREACTOREN. TEKSTEN VAN VOORDRACHTEN DIE TIJDENS DE ATOOMFORUMCONFERENTIE TE BUNNIK ZIJN GEHOUDEN OP 4 EN 23 MAART 1966. (Exponential Critical Experiments in Research Reactors. Text of the Papers Delivered at the Atom Forum Conference held at Bunnik [Netherlands] from March 4–23, 1966). RCN (Reactor Cent. Ned.) Meded., No. 22, 1-174(1968). (CONF-660312).

Included are 9 papers which describe various Dutch and U. S. research reactors, their experimental facilities, and their use for the measurement of reactor physics parameters. Separate abstracts were prepared for each of the 9 papers. (H.D.R.)

For abstracts of individual papers see: 25107–25115.

25107 SUBCRITICAL SUSPENSION REACTOR. Kersten, J. A. H. (KEMA, Arnhem, Netherlands). RCN (Reactor Cent. Ned.) Meded., No. 22, 9-30(1968). (In Dutch).

From Nederlands Atoomforum Conference, Utrecht. See CONF-660312.

A subcritical reactor was built for investigating aqueous suspensions of 10μ dia particles of 20% enriched UO_2 or 6μ dia particles of a 90% enriched UO_2–ThO_2 mixture. A continuous and a pulsed neutron source is used, the water temperature is stabilized to within 0.05°C. The critical U concentration is 198 and 333 g/l for the two types of fuel respectively. The influence of flow velocity, flow interruption, temperature, and pH of the suspension on the reactor behavior has been determined. The effective fraction of delayed neutrons was determined from the neutron flux fluctuations under operation with the pulsed neutron source. The neutron flux distribution in the reactor was measured with Dy and In activation. (J.J.t.B.)

25108 EXPERIMENTS FOR DETERMINING DIFFERENTIAL REACTOR PARAMETERS. Caspers, L. M.; Dekker, A. L.; Kleijn, H. R. (Technical Univ., Delft, Netherlands. Reactor Inst., Delft, Netherlands). RCN (Reactor Cent. Ned.) Meded., No. 22, 31-43(1968). (In Dutch).

From Nederlands Atoomforum Conference, Utrecht. See CONF-660312.

A H_2O-moderated natural U exponential pile, irradiated with neutrons from the thermal column of the HOR Reactor in Delft, has been used to measure the thermal yield and the resonance escape probability as a function of the air bubble fraction of the water and the U concentration. The results are compared with calculations. Resonance integrals of UO_2 have been measured with a locally modifying reactor oscillator in the thermal column of the same reactor, giving reasonable agreement with calculated values. Energy spectra of neutrons scattered by B-poisoned H_2O have been measured from 10^{-2}–1 eV with a time-of-flight spectrometer. Results agree with measurements by General Atomic and show a better agreement with the theoretical model by Nelkin than with the Brown-St. John-model. (J.J.t.B.)

25109 THE ROLE OF CRITICAL AND SUBCRITICAL EXPERIMENTS IN THE RCN-SHIP-PROPULSION REACTOR STUDY. Coehoorn, J. (Reactor Centrum Nederland, Petten, Netherlands). RCN (Reactor Cent. Ned.) Meded., No. 22, 45-69(1968). (In Dutch).

From Nederlands Atoomforum Conference, Utrecht. See CONF-660312.

Experiments with the H_2O-moderated ship-propulsion reactor KRITO and the subcritical device PUK, both using 3.1 and 3.8% enriched UO_2 rods, led in several stages of core modification and comparison with calculations to the third core arrangement: KRITO III. Details of design and results are given. It is expected that a few additional calculations will lead to final suggestions for a more favorable design. (J.J.t.B.)

25110 THE USE OF THE BIOLOGICAL AND AGRICULTURAL REACTOR (BARN). Oosterheert, W. F. (Inst. for Application of Atomic Energy in Agriculture, Wageningen, Netherlands). RCN (Reactor Cent. Ned.) Meded., No. 22, 71-9(1968). (In Dutch).

From Nederlands Atoomforum Conference, Utrecht. See CONF-660312.

The BARN- reactor in Wageningen is of the swimming-pool type using H_2O and 90% enriched U. It is used for irradiation experiments in biology and agriculture. Plants in a climate chamber with an area of 4 m^2 can be irradiated with a thermal neutron flux of 5×10^6 n/cm²/sec, accompanied by a gamma dose rate of 2.5 R/hr. Removal of a D_2O-moderator present between reactor and chamber gives a fast flux of 10^9 n/cm²/sec with 200 R/hr. A second irradiation facility is located in the thermal column. Difficulties due to the radiolysis of water that unexpectedly was present in several aluminum-enclosed components are described. (J.J.t.B.)

25111 THE USE OF THE HIGHER EDUCATION REACTOR (HOR). van der Heijden, A. W.; Kleijn, H. R.; Rijks, H. J. (Reactor Inst., Delft, Netherlands). RCN (Reactor Cent. Ned.) Meded., No. 22, 81-95(1968). (In Dutch).

From Nederlands Atoomforum Conference, Utrecht. See CONF-660312.

The HOR reactor in Delft serves primarily as a neutron source for research and instruction in physics and chemistry, but is also used for experiments in reactor physics. It is a swimming-pool reactor using H_2O and 90% enriched U. It is only used in the daytime. An analysis of emergency stops is given and safety precautions are discussed. (J.J.t.B.)

25112 RECENT APPLICATIONS OF THE LOW FLUX REACTOR (LFR) IN PETTEN. Coehoorn, J. (Reactor Centrum Nederland, Petten, Netherlands). RCN (Reactor Cent. Ned.) Meded., No. 22, 97-122(1968). (In Dutch).

From Nederlands Atoomforum Conference, Utrecht. See CONF-660312.

The reactor is of the ARGONAUT type. At full power (10 kW), it is used as a neutron source for subcritical experiments, biological irradiation experiments, shielding design, and several activation experiments and calibrations. At low power (0 to 10 W), experiments in reactor physics are performed, such as measurements of criticality, neutron flux and neutron spectrum; regulating rod calibrations; and determination of reactivity and temperature coefficients. In kinetic experiments the reactor behavior is modulated with either neutron pulses from an external generator or an oscillating absorbing sample. (J.J.t.B.)

25113 NATIONAL BUREAU OF STANDARDS REACTOR (NBSR): DESIGN AND USE. Muehlhause, C. O. RCN (Reactor Cent. Ned.) Meded., No. 22, 123-31(1968).

From Nederlands Atoomforum Conference, Utrecht. See CONF-660312.

The NBSR system of an open lattice of split fuel assemblies, moderated and cooled by heavy water, is described. The special in-core neutron moderator is discussed, and the principles of design and fabrication of special convertor elements are outlined. Engineering features relating to fine control, process water flow, and fuel handling are briefly discussed. (H.D.R.)

25114 THE USE OF THE HIGH FLUX REACTOR (HFR). Snepvangers, J. J. (Reactor Centrum Nederland, Petten, Netherlands). RCN (Reactor Cent. Ned.) Meded., No. 22, 133-56(1968). (In Dutch).

From Nederlands Atoomforum Conference, Utrecht. See CONF-660312.

The reactor is located at Petten and is of the swimming-pool type and presently operated at 20 MW. The highest obtainable neutron flux amounts to 1.6×10^{14} n/cm²/sec (thermal) and 1.1×10^{14} n/cm²/sec (fast). Neutron beams are used for neutron diffraction experiments (determination of atomic positions, spin waves, lattice movements) and nuclear spectroscopy. Neutron irradiations include several fissionable materials, graphite, steel and thermocouples. In a special graphite experiment, samples are irradiated at different temperatures but in the same capsule. Standard facilities are available for radioisotope production. (J.J.t.B.)

25115 BROOKHAVEN HIGH FLUX BEAM REACTOR: DESIGN AND USE. Kouts, Herbert J. RCN (Reactor Cent. Ned.) Meded., No. 22, 157-74(1968).

From Nederlands Atoomforum Conference, Utrecht. See CONF-660312.

The HFBR and associated experimental facilities are described. Startup procedures and experiments are presented, and some of the neutron physics characteristics of the reactor are discussed. Some of the control, shielding, and operating characteristics are briefly reviewed. (H.D.R.)

25116 RECENT EXPERIMENTS IN THE OPERATION OF RAPSODIE. Denielou, G. Energ. Nucl. (Paris), 10: 22-8 (Jan.-Feb. 1968). (In French).

A power history of Rapsodie is given. Results of measurements of dynamic characteristics, such as rod oscillation, sodium temperature at departure from a fuel assembly, sodium temperature at reactor entrance, reactivity, and integral power, are shown graphically. (M.L.S.)

25117 FAST BURST NEUTRONIC REACTOR. Bettis, E. S.; Westsik, J. H. (to United States Atomic Energy Commission). U. S. Patent 3,385,759. May 28, 1968.

A pulsed neutronic reactor incorporates a core arrangement wherein molten salt containing fissionable fuel floats on a reservoir of liquid metal. The molten salt fuel, driven upward through a tubulation by raising the level of the reservoir, becomes supercritical, emits a short intense burst of neutrons, and then becomes subcritical as it continues upward. The molten salt fuel then passes into an annular cooling cavity where liquid metal from the reservoir is discharged into the molten salt to cool it. The molten salt fuel is then returned to its initial position in preparation for repeating the cycle and generating another burst of neutrons. (AEC)

25118 JOINT FOR A MULTIPLE CONDUIT. (to Commissariat a l'Energie Atomique). French Patent 1,375,821. Sept. 14, 1964. Filed Aug. 13, 1963.

The conduits are used in cryogenic fluid supply for a device for low temperature irradiation within a nuclear reactor of the swim-

ming pool type. The arrangement comprises two rigid sections each constituted by a fluid conduit surrounded by a sheath and a sealed connection between the two sections. The connection has a fluid-tight rotating joint between the two sheaths, and a deformable connection between the two conduits. The axes of the two sections are rectilinear and oblique with respect to each other. The joint is located coaxially to one of the sections between the sheath of one section and a terminal casing carried by the other sheath in order to allow for the rotation of the first section about its axis. Between each conduit serving to convey liquefied gas and its sheath defining an evacuated enclosure is inserted an annular conduit serving to convey the gas in the vapor phase. (IIB)

25119 METHOD AND APPARATUS FOR UNDERWATER RADIOLOGICAL INSPECTION, ESPECIALLY IN A SWIMMING POOL REACTOR. (to Commissariat a l'Energie Atomique). French Patent 1,442,511. May 9, 1966. Filed May 6, 1965.

The purpose of the apparatus is to examine the state of a prototype fuel element located within the pressure tube of an irradiation loop. In order to perform the radiological inspection of a fuel element, viewing equipment must also be immersed in the reactor tank. Radiological inspection can be carried out by means which are adapted to move along the tube or around this latter under a layer of demineralized water and must be necessarily shielded by a liquid-tight casing. A radiological transmitter is located inside the casing for the production of radiation which passes through the fuel element to be examined, as well as a radiological receiver for collecting this radiation after its passage through the pressure tube. (IIB)

25120 IRRADIATION ENCLOSURE. (to Commissariat a l'Energie Atomique). French Patent 1,353,518. Jan. 20, 1964. Filed Dec. 28, 1962.

An irradiation enclosure for a nuclear reactor of the swimming pool type comprises a lower tube for containing a capsule or a sample to be subjected to irradiation. The upper end of the lower tube is closed by means of a sealed stopper. An upper tube is in communication with the lower tube, but not in alignment therewith, and rises out of the water of the pool. A sleeve is provided axially on the upper end of the lower tube, rising out of the water of the pool and permitting direct access to the stopper of the lower tube. (IIB)

25121 HIGH HEAT FLUX NEUTRONIC FUEL ELEMENT. G. E. Gorker (to United States Atomic Energy Commission). U. S. Patent 3,378,453. Apr. 16, 1968.

A fuel element for a boiling water reactor wherein fissile fuel is disposed about a cylindrical coolant channel containing an elongated insert centrally disposed along the length of the channel is described. The insert comprises a helical rib fixed to and spiraling about a central shank. The helical rib is spaced apart from the coolant channel wall along that portion of the channel surrounded by fissile fuel. Means are provided for imparting an initial vortex flow to liquid coolant entering the coolant channel. The liquid coolant is maintained in vortex flow along the remaining length of the coolant channel by the action of vaporized coolant generated in the coolant channel as it flows along a spiral path defined by the helical rib and shank portion of the central insert. (AEC)

Production Reactors

Refer to abstract 24991.

Reactor Theory, Components, Fuels and Accessories

Refer also to abstracts 23184, 23212, 23236, 23261, 23275, 23389, 23392, 23593, 23730, 23743, 23746, 23760, 23761, 23763, 23770, 23786, 23787, 23840, 23846, 23856–23858, 23868, 23873, 23874, 23877, 23879, 23881, 23882, 23884, 24413, 24791, 24793, 24794, and 24855.

25122 (AEEW-R-558) A COMPARISON OF THE ACCURACY OF SOME CORRELATIONS FOR BURNOUT IN ANNULI AND ROD BUNDLES. Barnett, P. G. (Atomic Energy Establishment, Winfrith (England)). Jan. 1968. 34p. Dep. CFSTI. UK 6s. 0d.

An earlier compilation of burnout data for annuli and rod bundles is up-dated. A comparison is made of the accuracy with which five correlations for burnout in annuli predict the compiled annulus data; one correlation is found to be significantly better than the rest when the data are viewed as a whole. The accuracy with which this correlation, and two of the other correlations, also predict the rod bundle burnout data is compared; the same correlation is again found to be the more likely to give accurate predictions. The implication of these observations is that it may be possible to make considerable savings in the cost of experimental and assessment work on rod bundles by studying their equivalent annuli. (auth)

25123 (BNWL-581) COMPARISONS OF THE CONTAINMENT BEHAVIOR OF A SIMULANT WITH FISSION PRODUCTS RELEASED FROM IRRADIATED UO_2. Hilliard, R. K.; Coleman, L. F.; McCormack, J. D. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Mar. 1968. Contract AT(45-1)-1830. 149p. Dep. CFSTI.

Experiments were performed in which either simulant aerosols or fission products released from heated trace-irradiated UO_2 were released into small vessels containing condensing steam-air atmospheres. The behavior of the two different types of aerosol materials was characterized and compared with each other and with transport theory. The conclusion was made that the simulant aerosol developed for the Containment Systems Experiment (CSE) is a fully satisfactory substitute for real fission products in containment transport tests investigating removal by natural processes. (auth)

25124 (BNWL-612) MAX: A ONE-DIMENSIONAL MAXIMUM HYPOTHETICAL ACCIDENT CODE IN FORTRAN-IV. Little, W. W. Jr. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Mar. 1968. Contract AT(45-1)-1830. 54p. Dep. CFSTI.

MAX is a one-dimensional (sphere, cylinder, plane) multi-zone code for computing the energy release in large nuclear excursions. The nuclear model consists of a point kinetics model with fixed worth and power distributions. Linear and Doppler reactivity feedback terms are included. The hydrodynamics model consists of many movable and compressible mesh intervals. Zone dependent equations of state, and heats of fusion can be employed. The reactivity input can be any piecewise-linear function of time. (auth)

25125 (BNWL-663) PROGRAM FOR CALCULATING THE STEADY-STATE DEFORMATION RATES FOR CYLINDRICAL FUEL ELEMENTS. Merckx, K. R. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Jan. 1968. Contract AT(45-1)-1830. 30p. Dep. CFSTI.

The assumptions, mathematical formulation, and the computer program calculating the steady-state behavior of cylindrical fuel pins are presented. A listing of the SWELL program used for swelling and mechanical behavior of the fuel and cladding material is included. (D.C.C.)

25126 (CEA-R-3342) CONTRIBUTION A L'ETUDE DES INSTALLATIONS DE DETECTION DE RUPTURES DE GAINE. (Study of Can Rupture Detection Installations). Douet, Paul; Graftieaux, Jean; Roguin, Andre (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Dec. 1967. 90p. (In French). Dep.

Numerous physical or technological parameters are involved in the preparation of projects for can rupture detection systems. These parameters are connected essentially with the design of the reactor, the detector used, the disposition of the pneumatic circuits, the type of fuel and the safety required. The main problems arising and their mutual compatibilities are described; ideas which have been accepted implicitly in the design are defined. (auth)

25127 (DUN-SA-57) THE APPLICATION OF THE HAMMER COMPUTER CODE TO EX-REACTOR CRITICALITY CALCULATIONS. Chitwood, R. A. (Douglas United Nuclear, Inc., Richland, Wash.). Feb. 9, 1968. Contract AT(45-1)-1857. 5p. (CONF-680601-4). DTIE.

From 14th Annual Meeting of the American Nuclear Society, Toronto, Ontario.

A description of the Hammer System computer code for determining the criticality parameters on arrays of slightly enriched uranium tubes in H_2O is presented. Calculations are presented for six various geometry configurations. (D.C.C.)

25128 (IA-1128, pp 1-11) REACTORS AND REACTOR PHYSICS. (Israel Atomic Energy Commission, Tel Aviv).

Activities are summarized and references are listed for work performed during 1966 on: multigroup diffusion and multigroup cross sections, group diffusion with elastic moderation, basic nuclear data for fast reactor calculations, basic nuclear data for high plutonium isotopes, application of the perturbation method to reactor physics problems, temperature effect on neutron scattering kernels, solution of the neutron moderation problem in non-hydrogenous infinite homogeneous media with capture, and periodic solution of the mono-energetic Boltzmann

equation. Descriptions and diagrams are presented for the automatic power control system of the IRR-1 reactor and an installation for automatic scanning of an activated wire. The experimental facilities are listed for the IRR-2 reactor. (H.D.R.)

25129 (IN-1178) BURNUP DETERMINATION OF NUCLEAR FUELS. Project Report for the Quarter, April 1-June 30, 1967. Lisman, Frederick L.; Maeck, William J.; Rein, James E. (eds.) (Idaho Nuclear Corp., Idaho Falls). Apr. 1968. Contract AT-(10-1)-1230. 16p. Dep. CFSTI.

In a continuing program to develop methods for the accurate determination of the burnup of nuclear fuels, the main emphasis was additional measurements of the absolute, thermal fission yields of stable and long-lived isotopes of krypton, xenon, rubidium, and ruthenium for ^{135}U. Also measured was α, the thermal capture-to-fission ratio, for ^{235}U. The determined values are presented. (auth)

25130 (KAPL-P-3425) SPACE-TIME REACTOR KINETICS DEVELOPMENT AT KAPL. Stacey, Weston M. Jr. (Knolls Atomic Power Lab., Schenectady, N. Y.). Mar. 1968. Contract W-31-109-eng-52. 42p. (CONF-680414-1). Dep. CFSTI.

From Conference on Industrial Needs and Academic Research in Reactor Kinetics, Upton, N. Y.

Efforts in the development of methods for the calculation of transient power distributions in operating reactor cores during a variety of plausible transients are reviewed. The development of Xenon spatial transient analysis and space-time flux synthesis is examined. Studies on defining nodal coupling coefficients and on the influence of spatial effects on the kinetics of low source reactor startups are also discussed. (H.D.R.)

25131 (LA-DC-8100) NUMERICAL INVESTIGATION OF THE STABILITY OF REACTORS WITH ^{135}Xe. Sandquist, Gary M. (Utah Univ., Salt Lake City. Idaho Nuclear Corp., Idaho Falls. Los Alamos Scientific Lab., N. Mex.). [1964]. Contract W-7405-eng-36. 5p. Dep. CFSTI.

The description of a computer program to simulate the nonlinear behavior of energy dependent, multidiminsional, multiregional systems under the influence of Xe is presented. XKINEQ is a FORTRAN coded program which simulates the two-energy group, diffusion type, nonlinear kinetic equations and examines the two-dimensional radial-axial time behavior in multiregional cylindrical cores and any two-dimensional time behavior in multiregional rectangular cores. (D.C.C.)

25132 (LA-DC-9519) ENERGY SOURCES OF THE FUTURE WITH EMPHASIS ON THE LIGHT ELEMENTS. Tuck, James L. (Los Alamos Scientific Lab., N. Mex.). [1967]. Contract W-7405-eng-36. 7p. (CONF-680502-2). Dep. CFSTI.

From 6th IEEE Region Conference, Portland, Ore.

A discussion of available power sources and their efficient application is presented. A review of fossil fuel reserves and hydroelectric and solar energy potentials is discussed. The description and aspects of nuclear fission and fusion energies are described. (D.C.C.)

25133 (NAA-SR-12549) FISSION EFFECTS IN METAL FUELS. Final Report. Anderman, A. I.; Gehman, W. G.; Holmes, J. J.; Willis, A. H. (Atomics International, Canoga Park, Calif.). Mar. 25, 1968. Contract AT(04-3)-701. 44p. Dep. CFSTI.

Sixty-four samples of heat-treated U-4 wt % Mo and U-10 wt % Mo alloys, with and without ternary additions, were irradiated to 0.8 and 1.4 at.% burnup at temperatures of 550 and 645°C. In general, uranium alloys without molybdenum performed poorly under these irradiation conditions. The best alloy specimens (U-Mo-Si and U-Mo-Sn) gave volume increases approximating the values expected from the accumulation of solid fission products. Solution-quenched materials exhibited smaller volume increases than did thermally produced fine or coarse dispersions. Selected specimens of U-Mo-Si exhibited similar very low volume increases at 0.5 at.% burnup and 435 to 510°C. The mechanism of rare gas atom migration and trapping was studied in lightly irradiated copper foils by measuring gas release during subsequent annealing. The kinetics of gas release were found to be nondiffusional, and the total amount of gas released was always a small fraction of the total gas content. These results indicate that gas release was controlled by the dissociation of gas atoms from internal traps, which are numerous ($>10^{18}/cm^3$), deep ($\gtrsim 0.08$ eV), and relatively immobile. It was not possible to resolve gas evolution vs. temperature curves into simple segments representing single trapping mechanisms. The effect of fission during proton irradiation on the creep of thorium, at temperatures of 273 to 473°K, was measured. Both a weakening and a strengthening effect were found, as well as a recoverable creep strain. Fission was found to induce creep at stresses where none would occur in the absence of fission, and this creep appeared to be athermal. Small creep strains so produced were recoverable, upon removal of the proton beam. The influence of fission on creep is interpreted in terms of the interactions between moving dislocations and defects produced by displacement damage. A computer investigation of some fundamental atomic characteristics relevant to fuel swelling phenomena has been performed. The primary focus of the work was the study of the formation energies and lattice strain fields of small xenon-vacancy clusters in a copper matrix. For small clusters containing one to a few Xe atoms, stability increases with increasing number of vacancies. The configuration is often also important, stability increasing with increasing nearest-neighbor coordination between vacancies and Xe atoms. Clusters of about a dozen Se atoms are stable (relative to isolated defects), if about half that number of vacancies are associated. Diffusion of an isolated, substitutional Xe atom in the ⟨110⟩ direction in copper to an adjacent vacancy was found to have a negative midpoint energy; whereas normal, positive activation energies were found for Ne, Ar, and Kr. The anomaly is attributed to the large size of the Xe atom. (auth)

25134 (PRNC-117) A STUDY OF COMPUTATIONAL METHODS USED TO DETERMINE FUEL DEPLETION IN NUCLEAR REACTORS. Gileadi, Aviva E.; Lee, Cho-Fu (Puerto Rico Nuclear Center, Mayaguez). Mar. 1968. Contract AT(40-1)-1833. 257p. Dep. CFSTI.

Thesis. Submitted by Cho-Fu Lee to Univ. of Puerto Rico, Mayaguez.

The problem of fuel depletion is studied in uranium fueled, light water moderated, thermal reactors. The fitted cross-section scheme is used to compute fast few-group constants. Depletion equations were derived for pure U-235 fuel as well as for U-235 and U-238 mixtures. The assumption of constant power versus constant flux is discussed. An extensive survey of depletion codes that have been developed to date is described. The codes are charcterized by means of relevant data, including: reactor geometry option, number of regions, number of mesh points, number of energy groups, burnable poison option, type of computer for which the code has been written, programming language used, and running time for a typical problem. A Friden electric desk computer is used to compute depletion effects for two highly simplified models. A computer code BURNUP written in FORTRAN II is developed for the IBM 1620 computer; the code will calculate depletion effects for an enriched uranium fueled and light water moderated homogeneous reactor model, using the few-group scheme. (auth)

25135 (SNE-38) INVESTIGATION OF THE USE OF AQUEOUS SOLUTIONS AS EMERGENCY COOLANTS. Quarterly Report No. 1. McCullough, C. Rogers; Brown, Gilbert M.; Hancock, R. P. (Southern Nuclear Engineering, Inc., Dunedin, Fla.). Apr. 1, 1968. Contract AT(40-1)-3749. 18p. Dep. CFSTI.

The benefits of using additives in water as the emergency coolant for reactor cores are determined. The test results of spray-cooled Zircaloy cladding are presented. Durability tests for the heater cladding of stainless steel and thermocouple error determination are described. (D.C.C.)

25136 (TRG-Report-940) STYLE: A GENERAL DIGITAL COMPUTER CODE FOR THE ANALYSIS OF STEAM CYCLES FOR MARINE AND LAND-BASED POWER PLANTS. Love, J. B.; Dines, W. R. (United Kingdom Atomic Energy Authority, Risley (England). Reactor Group). Oct. 15, 1967. 60p. Dep. CFSTI. UK 8s.

An IBM 7090 digital computer code for the analysis of a wide variety of steam cycles including single reheat and multistage moisture separation is described. The code is intended to assist the nuclear reactor designer in the choice of the most suitable type of steam cycle and in the choice of optimum steam conditions. Though no attempt is made to carry out a detailed turbine blading design, the code is capable of automatically varying the blading efficiency from stage to stage according to the local steam volume flowrate, dryness fraction and shaft speed. Facilities are also available for including the steam-consuming auxiliaries associated with a marine installation in the heat balance calculation performed by the code. Two examples of the use of the code are given, one relating to a large land-based A.G.R. power station and the other to the steam plant of a nuclear merchant ship. (auth)

25137 APPROXIMATE ZERO-POWER DESCRIBING FUNCTION VALID AT ALL FREQUENCIES. Akcasu, A. Ziya; Shotkin, Louis M. (Brookhaven National Lab., Upton, N. Y.). Nucl. Sci. Eng., 32: 271-3(1968). (BNL-11780).

The definition of a describing function, which is amplitude dependent, for the reactor kinetics equations without external sources and without feedback is presented. (auth)

25138 CONTROLLABILITY OF NEUTRON-FLUX DISTRIBUTION. Suda, Nobuhide (Osaka Univ.). Nucl. Sci. Eng., 32: 273-4(1968).

Sufficient conditions for the controllability of the flux distribution approximated with a finite number of modes are given by Wiberg as: any finite number of modes of the reactor model are controllable if there are at least as many control rods as the maximum multiplicity, max J_m; and all control rods are not on any possible modes of a combination of modes having the same eigenvalue. Verification is presented. (auth)

25139 EFFECTIVE CADMIUM CUTOFF ENERGIES FOR FINITE CYLINDRICAL FILTERS WITH FINITE-SIZE DETECTORS. Glickstein, S. S.; Hall, W. J. (Bettis Atomic Power Lab., West Mifflin, Pa.). Contract AT(11-1)-Gen-14. Nucl. Sci. Eng., 32: 364-5(1968). (WAPD-T-2076).

The evaluation of Cd cutoff energies for finite cylindrical filters with finite-size detectors is presented. (auth)

25140 INTERFACE CONDITIONS FOR FEW-GROUP NEUTRON DIFFUSION EQUATIONS WITH FLUX-ADJOINT WEIGHTED CONSTANTS. Buslik, A. J. (Bettis Atomic Power Lab., West Mifflin, Pa.). Contract AT(11-1)-Gen-14. Nucl. Sci. Eng., 32: 233-40(1968). (WAPD-T-2073).

Few-group diffusion equations are derived from variational principles. It is shown that by proper choice of trial function it is possible to derive a few-group theory in which interface boundary conditions of continuity of few-group fluxes and currents are obtained, even when the few-group constants are obtained by flux-adjoint weighting. The analysis is facilitated by the use of functionals that incorporate the interface condition of flux continuity by means of Lagrange multipliers. Two functionals are used to give two variants of the theory. Both functionals have as Euler equations the P-1 approximation to the time-independent, eigenvalue form of the energy-dependent transport equation. In addition, the current and flux interface boundary conditions are part of the complement of Euler conditions of the functionals. The functionals admit trial functions discontinuous in space and energy. The two functionals differ in that one has both flux and current arguments, whereas the other has only flux arguments, and yields the P-1 equations in second-order diffusion form. (auth)

25141 ON THE USE OF ^{164}Dy, ^{176}Lu, AND ^{239}Pu IN THERMAL-NEUTRON SPECTRUM DETERMINATIONS. Volpe, J. J. (Bettis Atomic Power Lab., West Mifflin, Pa.). Nucl. Sci. Eng., 32: 262-74(1968).

Detectors such as ^{164}Dy, ^{176}Lu, ^{239}Pu, and ^{235}U are used in integral and differential experiments such as thermal-neutron spectrum sampling in a variety of reactor cells. The quantity of interest, referred to as the spectral index, is defined as the ratio of a detector activation relative to ^{164}Dy, normalized to the same ratio as measured in a known thermal flux. The lattices under consideration are simple cells with slightly enriched or natural uranium fuel and light water moderator. Calculations presented are derived from THERMOS calculations with Honeck's modified Nelkin model for fuel and moderator temperatures of 21 and 27°C. An analysis of errors in the calculations is presented. (D.C.C.)

25142 TECHNIQUE FOR THE DETERMINATION OF RATIOS OF EFFECTIVE CROSS SECTIONS FROM REACTOR FUEL BURNUP DATA. Matsen, R. P. (Battelle Memorial Inst., Richland, Wash.). Contract AT(45-1)-1830. Nucl. Sci. Eng., 32: 267-70(1968). (BNWL-SA-1428).

A technique for analyzing burnup data is presented. Results of the analysis of Al–Pu fuel elements are expressed as ratios of flux-averaged cross sections. The ratios constitute a compact set of experimental numbers that can be compared with those obtained using reactor analysis codes. The cross-section ratios result from a simultaneous fit of the integrated transmutation equations to the burnup data using the method of least squares. (auth)

25143 STUDY OF ONE-SPEED MULTIREGION TRANSPORT PROBLEMS IN PLANE GEOMETRY BY THE METHOD OF BOUNDARY SOURCES. Beauwens, R.; Devooght, J. (Univ. Libre, Brussels). Nucl. Sci. Eng., 32: 249-61(1968).

A method for solving multiregion transport problems, which is a generalization of integral transport theory as typified by the well-known Amouyal-Benoist-Horowitz method, is presented. The theorem of uniqueness of the solution of Boltzmann equation is used to reduce the problem to a series of associated problems, the Green's functions of which are supposed to be known, with appropriate sources at region boundaries. A system of integral equations is obtained for the sources. One-speed, plane geometry, and infinite medium problems are the restrictions. The numerical results presented appear to be very good compared with other methods. (auth)

25144 CHEMICAL RESEARCH FOR THE BENEFIT OF THE DEVELOPMENT OF FUEL ELEMENTS. Cordfunke, E. H. P. RCN (Reactor Cent. Ned.) Meded., No. 29, 75-89(1967). (In Dutch).

In the post-war years chemical research for the benefit of the development of fuel elements was directed mainly towards U and U alloys. Since 1955 this interest has shifted for several reasons to UO_2. The applicability of this oxide as a fuel element has raised a great number of chemical problems. Besides UO_2 other materials have gained interest, such as PuC, PuN, UC, and UN. (tr-auth)

25145 REALISTIC DATA ARE NEEDED FOR MECHANICAL ANALYSIS OF REACTOR FUEL ELEMENTS. Valentin, Richard A. Reactor Fuel Process. Technol., 11: 13-16(Winter 1967-68).

To illustrate the difficulties involved in theoretical predictions of thermal displacements, stresses, and strains and radiation-induced creep and swelling effects in reactor fuel elements, two papers on theroretical transient mechanical analysis of fuel elements are reviewed. One paper concerns the formulation of a mathematical model for predicting the stresses and strains in a solid, thinly clad, circular cylindrical fuel element over a long time period during which essentially steady-state conditions have existed. The second paper discusses the transient growth effects for the same fuel-rod geometry during time ranges of the order of reasonable positive reactor periods (one minute or less). The many assumptions needed to produce tractable problem formulations and the influence of the time range on the mathematical models and analytical methods that can be employed are emphasized. 8 references. (H.D.R.)

25146 FUNDAMENTAL PROBLEMS OF HEAVY WATER DOSIMETRY IN NUCLEAR REACTORS. David, Lubomir; Tomaskova, Lenka (Ustav Jaderneho Vyzkumu, Prague). Jad. Energ., 14: 11-20(Jan. 1968). (In Czech).

D_2O utilized in heavy water moderated-reactors is influenced by many variables and constantly changes as these influences exert their effect. Studied are the basic processes associated with the production of radionuclides in heavy water moderator by neutron activation as well as impurities originally present in the moderator, corrosion products circulating in the heavy water, and fuel element rupture or other accidents releasing radionuclides into circulating system. Principal objectives are identification of the radioactive nuclides present in heavy water at various stages in the reactor facility and application of measurement techniques in qualitative and quantitative determination of these radionuclides and their sources. Monitoring of radioactive materials in the moderating water is of great importance to the nuclear engineering and essential to safe reactor operations. Included are 90 references published in recent years. (auth)

25147 DEVELOPMENT OF INTERNAL REACTOR AXIAL PUMPS. Gaffal, K. (Klein, Schanzlin, and Becker, Frankenthal/Pfalz, Ger.). pp 63-73 of Development of Light Water Reactors in the Community. Brussels, Euratom, 1967. (In German).
See EUR-3561; CONF-661134.

Design parameters for an internal axial pump for a reactor system are given; pump components are described. Pump anchorage in the pressure vessel is discussed; general maintenance of shaft packing and bearings in considered. (M.L.S.)

25148 STUDY OF LATTICES OF GRAPHITE WITH EMPTY CHANNELS BY MEANS OF THE PULSED SOURCE TECHNIQUE. Deniz, V. (CEN Saclay, Gif-sur-Yvette, France); Le Ho, J. G.; Sagot, M. Nucl. Sci. Eng., 32: 201-24(1968).

A detailed study of heterogeneity effects in lattices, and in particular of the streaming effects introduced by the presence of channels, is presented for studying graphite lattices by the pulsed source technique. The aim of the project is to obtain experimental data on clean simple systems for testing the methods used in lattice calculations. The results obtained in the study of empty-channel lattices are presented. Detailed expressions are obtained for non-multiplying lattices, and wherever it was possible without digressing too much from the context, multiplying lattices are also discussed. A method is presented for the direct calculation of decay constants in multiplying or non-multiplying lattices, a particular form of which can be used for the calculation of critical bucklings. Experiments have been performed on lattices with a square pitch of 20-cm side, the channel radii studied being 1.5, 2.5, 3.5, 4.5, 5.5, and 7 cm. Since the object was to determine if the anisotropy effects introduced in the diffusion coefficients by the cell geometry could be properly interpreted, the theoretical calculations have been limited to one-velocity treatments, which should be adequate for empty-channel systems. The comparison between experiment and theory is quite satisfactory, though some discrepancy is observed with the axial diffusion coefficient in the case of the large channel radii. The experiments indicate, furthermore, that the diffusion cooling coefficients vary very rapidly with channel radius. The consideration of extrapolation

lengths of empty-channel graphite is discussed. Approximate analytical calculations as well as a numerical calculation utilizing the TDC code have been presented. They indicate that it is reasonable to consider the extrapolation length as being equal to 0.71 times the cell mean-free-path associated with the direction considered. (auth)

25149 FORMAL SOLUTION TO THE NEUTRON MODERATION PROBLEM IN NONHYDROGENOUS INFINITE HOMOGENEOUS MEDIA. Finkelstein, Leib (Israel Atomic Energy Commission, Yavne). Nucl. Sci. Eng., 32: 241-8(1968).

A complete inverse mass expansion is derived for the difference-differential equation describing neutron moderation in infinite homogeneous media, far energetically from the sources. Slowing down equations with different values of the nucleus-to-neutron mass ratio, and a common value of the capture-to-scattering cross-section ratio are considered. The latter is assumed to be an analytic function of lethargy. A preliminary analysis suggests the functional form of the leading term of the expansion. Further treatment leads to a first-order, linear, inhomogeneous, ordinary differential equation satisfied by the expansion terms. Different terms of the expansion correspond to different free terms of the differential equation. Imposing a normalization condition, the solution of the differential equation is made unique, and a formal, practically effective solution to the general asymptotic moderation problem is obtained. (auth)

25150 ROLE OF BORON-CONTAINING CONCRETES AS NUCLEAR REACTOR SHIELDS. Zaitsev, L. N.; Lavdanskii, P. A.; Mal'kov, V. V.; Sychev, B. S. Beton Zhelezobeton, No. 7, 32-4(1966). (In Russian).

The addition of boron to biological shielding made from ordinary concrete reduces its thickness by 27% when the content of chemically combined water is low, and by 23% when the amount of water in the concrete is 75 kg/m^3 (with a dosage ratio of $D_1^0/D_2^0 = 10^{-3}$). Maximum reduction in shielding thickness due to the addition of boron to heavy concrete for ore-filled concrete with a volumetric weight of 3200 kg/m^3 is 3% (when the ratio between the dosages is $D_1^0/D_2^0 = 10^{-1}$). Thus, the addition of boron is not economically advantageous since it results in only a small savings in concrete. Exceptions are reinforced concretes with a very small amount of water or those entirely without combined water, such as heat-resistant concretes. (auth) (ATD)

25151 DR. A. B. CHILTON'S COMMENT ON "CONCRETE BUILDUP FACTORS". Clark, Frances H. (Oak Ridge National Lab., Tenn.). Nucl. App., 4: 287(May 1968).

A discussion on the accuracy of measuring buildup factors in concrete is presented. Differences in the works of A. B. Chilton and Clark and Trubey are indicated. (D.C.C.)

25152 CONCRETE BUILDUP FACTORS. Chilton, A. B. (Univ. of Illinois, Urbana). Nucl. Appl., 4: 286-7(May 1968).

A discussion on the accuracy of measuring buildup factors in concrete is presented. Differences in the works of Clark and Trubey and the author are indicated. (D.C.C.)

25153 CO_2 AS A MODERATOR. Diamond, Joseph M. Nucl. Appl., 4: 287-8(May 1968).

The advantages of using liquid or solid CO_2 as a reactor moderator are presented. The nuclear properties of oxygen compounds are tabulated and compared. (D.C.C.)

25154 SOME QUESTIONS OF NONLINEAR OSCILLATIONS IN NUCLEAR REACTORS. Kryanev, A. V.; Shikhov, S. B.; Gorbunov, V. P. (Moscow Engineering-Physics Inst.). Vestsi Akad. Navuk BSSR, Ser. Fiz.-Tekh. Navuk, No. 4, 18-22(1967). (In Russian).

Different approximation methods were used during the calculation of the self-oscillation regime in reactors. However these methods left open questions on the existence of self-oscillation regimes. For proof of the existence of this type of periodic regime, the method of small parameters is illustrated. (tr-auth)

25155 REVIEW OF NUCLEAR FUEL REQUIREMENTS AND RESOURCES. Faulkner, R. L. (Atomic Energy Commission, Washington, D. C.). 7p. of International Conference and Exhibition on a World Review of Nuclear Reactors and Radioisotopes, Montreal, Quebec, Canada, May 28-31, 1967. Toronto, Canadian Nuclear Association, 1967. (CONF-670522-12; 67-CNA-410).

Estimates of known uranium ore reserves and the scale of exploration needed to meet fuel requirements for reactors up to 1990 are discussed. (F.S.A.)

25156 BRAZING AND WELDING OF ZIRCALOY CLAD FUEL ASSEMBLIES. Bates, K. T. (Canadian Westinghouse Co. Ltd., Port Hope, Ont.). 12p. of International Conference and Exhibition on a World Review of Nuclear Reactors and Radioisotopes, Montreal, Quebec, Canada, May 28-31, 1967. Toronto, Canadian Nuclear Association, 1967. (CONF-670522-10; 67-CNA-417).

Resistance welding and brazing developed to production scale operations are important contributing factors to the low cost of Canadian fuel. The joint properties required for reactor service conditions are discussed and the testing procedures described. Production equipment incorporates automatic feeding which processes about 50 elements/hour. Brazing of the inter-element Zircaloy spacer pads uses a combination of high frequency induction heating and glass wall vacuum systems. Metallurgical structure and other properties of the joints are discussed. The integrity under irradiation has been tested over the past seven years in NRX and NRU. (F.S.A.)

25157 DEVELOPMENT OF PRODUCTION TECHNIQUES FOR URANIUM SILICIDE. Hueston, F. H. (Eldorado Mining and Refining Ltd., Port Hope, Ont.). 16p. of International Conference and Exhibition on a World Review of Nuclear Reactors and Radioisotopes, Montreal, Quebec, Canada, May 28-31, 1967. Toronto, Canadian Nuclear Association, 1967. (CONF-670522-15; 67-CNA-420).

Triuranium silicide (U_3Si) with a theoretical density of 15.58 gms/cc and a thermal conductivity of 0.036 cal/sec/cm^2/cm/°C at room temperature possesses some attractive properties as a nuclear fuel. The development of production techniques necessary to make this fuel competitive with others is discussed. (auth)

25158 THE NUCLEAR FUEL INDUSTRY. Sauteron, Jean. Sciences (Paris), No. 51, 32-45(Sept.-Oct. 1967). (In French).

A review of the history of the industry covers the overproduction of uranium-bearing ores beginning in 1958, with figures for Canada, South Africa, and France. The refinement of U minerals to the final product is outlined in detail. Metallic and ceramic fuels are noted. Second-generation reactors, fast neutron-Pu surgenerators, are now in the testing stage in France (Rapsodie). The mechanical and radiation hazards of handling Pu are discussed; PuO_2 can be manipulated much as UO_2. The applicability of Th seems more remote, because it is not fissile and produces only one fissile product, ^{233}U, under neutron bombardment. The future of reprocessing is discussed; several procedures (solution, extraction, volatilization, pyrometallurgy) are noted. The possible application of ^{237}Np, ^{241}Am, and ^{243}Am in the future is also discussed briefly. The problem of treatment of irradiated fuels will remain the subject of research for some years to come. (BBB)

25159 NUCLEAR REACTOR FUEL ELEMENTS. Gatley, John Andrew; Webb, John; Gallie, Reginald Robert (to United Kingdom Atomic Energy Authority). British Patent 1,107,384. Mar. 27, 1968. Filed Aug. 28, 1964.

The description of fuel element for a liquid-cooled nuclear reactor is presented. The fuel element contains a vent tube for gaseous fission product release. The vent path has a bore of capillary tube size and is coiled at the end of the fuel element to provide time for decay of short-lived gaseous fission products. (D.C.C.)

25160 IMPROVEMENTS IN AND RELATING TO NUCLEAR FUEL ELEMENTS. (to Babcock and Wilcox Co.). British Patent 1,107,858. Mar. 27, 1968. Priority date July 24, 1964, United States.

The description of a nuclear reactor fuel element is presented. The fuel element consists of a number of spaced Al or Al-based alloy clad fuel plates welded on oblong sides. The fabrication process is described. (D.C.C.)

25161 FUEL ELEMENT FOR A NUCLEAR REACTOR. Mogard, Johan Hilding (to Aktiebolaget Atomenergi). British Patent 1,108,054. Apr. 3, 1968. Priority date July 24, 1964, Sweden.

A description of a nuclear reactor fuel element consisting of a hollow tubular body of fissile fuel with protective coatings on the outer and inner surfaces is presented. The fuel element is cooled by fluid passing on the outside and inside of the element. The inner surface of the fuel element contains spaces parallel to the longitudinal axis of the tubular body and are gas-filled or evacuated to provide a heat insulating layer between the tube surface and the protective coating. (D.C.C.)

25162 PULSED NEUTRON ANALYSIS IN COUPLED-CORE NUCLEAR REACTORS. Hopkins, George Clair. Lafayette, Ind., Purdue Univ., 1967. 159p.

Thesis.

A review and comparison are made of the Los Alamos Coupled Reactor Pulsed Neutron Experiment and the theoretical model formulated by C. G. Chezem and H. H. Helmick for the analysis of this experiment. Results are shown indicating the existence of "oscillatory" deviations superimposed on the exponential behavior of the neutron response to a "delta" pulse of neutrons introduced at t = 0 into one of the cores of a two-core coupled array. The roots obtained from the characteristic equation of

the Chezem-Helmick model are shown to be all real, thus precluding the possible theoretical existence of damped oscillations. A generalized multi-energy group point kinetics formulation is derived systematically from the Boltzmann transport equation, including an explicit treatment and definition of the effective surface sources and the kinetic parameters. This model, distinct from any previous formulation, encompasses m energy groups, n_c core regions, and n_r reflector regions, and allows full flexibility in the choice of a time-dependent distribution function, including delay times, for neutrons in transit between spatial regions or energy groups. Two approximations are made to the generalized model. The first, a one-energy group, bare core formulation for two cores, is analyzed using the Laplace transform-residue method, and incorporating a distribution function containing delay time effects. Complex roots obtained from the transcendental characteristic equation indicate the possible existence of oscillatory terms. Results are presented that indeed do show inflections in the neutron response curves, due to the effects of the delayed arrival of neutrons from the other core. The second approximation made, and analyzed, is a one-energy group, reflected core formulation, for two cores. This model, which incorporates both a between-core delay time, and a reflector delay time, is analyzed in the same manner as the one-group, bare core model. The transcendental characteristic equation again yields complex roots. With an additional delay time included, the effects of the reflectors are seen to "mute" the rate of the transient response observed in the bare core model. Under critical-state conditions, however, very definite oscillations are observed to exist in the neutron response for both cores. (Diss. Abstr.)

25163 SUPPORT STRUCTURE FOR A TANK OF A NUCLEAR REACTOR. (to Commissariat a l'Energie Atomique). French Patent 1,447,271. June 20, 1966. Filed June 3, 1965.

Support structure for the pressure tubes in a nuclear reactor calandria tank is provided. The support structure carries tubes which circulate a cooling fluid under pressure. The structure comprises an assembly of closed box elements, each box element being adapted to support at least one pressure-tube extension which traverses through the box element. The box elements are supported on each other by means of bearing points, structural rigidity being provided by prestressing cables which are passed through the support structure within passageways formed in the box elements. (IIB)

25164 DEVICE FOR REGULATING THE POWER OF A NUCLEAR REACTOR. (to Commissariat a l'Energie Atomique). French Patent 1,368,891(Add.2). Jan. 31, 1966. Filed Oct. 13, 1964. 2nd Addition 86,619.

The device has a neutron-absorbing element consisting of at least one chain adapted for manipulation within the channel extending through the reactor core. Each chain comprises a first portion of neutron-absorbing material and a second portion of non-absorbing material, both of the portions extending end to end so that they act on the reactivity of the reactor according to which portion of the chain is situated in the channel of the reactor. (IIB)

25165 SHOCK ABSORBER. (to Electricite de France). French Patent 1,448,890. July 4, 1966. Filed June 15, 1965.

A basket or cup-shaped member is disposed at the bottom of a nuclear reactor channel to support energy absorbing elements having a known tensile strength resistance. The basket has a central aperture through which a rod extends freely, the top of the rod having a flattened head to receive the impact of a falling fuel element. The other end of the rod is integral with a disc resting on the heads of cylindrical energy absorbing elements which extends through the bores in the disc and are secured in the base of the basket. When the head receives the shock, it tends to move outwardly of the basket but the energy absorbing elements resist this movement and allows it to occur only in proportion to its elongation or limit resistance. Some of the energy absorbing elements are of different dimensions in order to operate successively, depending upon the magnitude of the shocks to be absorbed. (IIB)

25166 MECHANISM TO COMMAND THE POSITION OF NUCLEAR REACTOR SAFETY OR CONTROL RODS. (to Commissariat a l'Energie Atomique). French Patent 1,460,907. Oct. 24, 1966. Filed Oct. 22, 1965.

The mechanism comprises three operating members which are pivotally coupled to each other. The operating members are constituted respectively by a first vertical operating member which terminates in a control rod grab, by an intermediate member which forms a lever arm and by a second vertical operating member which extends outside the reactor tank. The intermediate member is provided between its pivoting points with a transverse fulcrum-pin which is pivotally mounted in a bearing secured to a vertical support rod which also extends outside the reactor tank. (IIB)

25167 DEVICE FOR REGULATING THE POWER OF A NUCLEAR REACTOR. (to Commissariat a l'Energie Atomique). French Patent 1,368,351(Add.1). Feb. 8, 1965. Filed Oct. 30, 1963. 1st Addition 84,641.

The power of a nuclear reactor is regulated by means of a neutron absorbing element comprising a single metal chain which is displaced within a vertical channel extending through the reactor core. In the withdrawn position, the chain is arranged within a detachable container mounted at the upper portion of the channel. The links of the chain co-operate with a driving sprocket wheel situated above the container. (IIB)

25168 DEVICE FOR REGULATING THE POWER OF A NUCLEAR REACTOR. (to Commissariat a l'Energie Atomique). French Patent 1,368,891. June 29, 1964. Filed June 25, 1963.

The power of a nuclear reactor is regulated by means of a neutron absorbing element comprising at least one metal chain which is displaced within a vertical channel extending through the reactor core, between a "withdrawn" position in which it is entirely outside the core and a "deployed" position in which it occupies substantially the entire height of the core. In the withdrawn position, the chain is arranged within a detachable container situated in alignment with the channel. (IIB)

25169 IMPROVEMENTS RELATING TO NUCLEAR REACTOR FUEL ELEMENT ASSEMBLIES. Barker, Allan; Bool, Alan Gilbert; Ackroyd, Ronald Tunstall; Dodd, John Alan (to United Kingdom Atomic Energy Authority). British Patent 1,108,763. Apr. 3, 1968. Filed Sept. 4, 1964.

The description of a nuclear reactor fuel assembly is presented. The fuel assembly is formed by sheathed fuel plates with fuel located in symmetric swellings in the plates. The alternating arrangement of the plates provides a smoothly undulating corrugated profile for coolant flow. The plates are joined by bridge pieces between the swelling which serve as continuous spacer ribs. (D.C.C.)

25170 IMPROVEMENTS RELATING TO NUCLEAR REACTOR FUEL ASSEMBLIES. Hackney, Stanley (to United Kingdom Atomic Energy Authority). British Patent 1,108,350. Apr. 3, 1968. Filed Oct. 29, 1965.

The description of a reactor fuel assembly which contains a burnable poison is presented. The burnable poison is made of parallel plates which allow a liquid moderator to flow freely but with more restriction than flow through fuel containing plates. The burnable poison plates are arranged in a pack of parallel spaced plates. (D.C.C.)

25171 CONTROL AND STABILITY ANALYSIS OF SPATIALLY-DEPENDENT NUCLEAR REACTOR SYSTEMS. Hsu, Chun. Lafayette, Ind., Purdue Univ., 1967. 121p.

Thesis.

A fundamental approach to the study of the dynamics of spatially dependent nuclear reactor systems is developed. This approach is aimed at treating reactor dynamics problems from the system's partial-differential equations without finding the solution or engaging any approximation to a lumped parameter model. A dynamical model of a spatially-dependent process in nuclear reactors is formulated. The model is general and may include the spatial effects of deterministic processes such as control devices and temperature. The extended method of Lyapunov, for distributed parameter systems, is then employed to analyze the stability of the system formulated above. A method of using the well-known spectral theory of Von Neumann is also introduced to analyze certain classes of linear and/or nonlinear spatially dependent dynamical systems. The application of the maximum principle to the optimal control system design for spatially dependent reactor systems is demonstrated for several classes of optimization problems. The practicality of optimal control for nonlinear systems is discussed, and a practical technique for suboptimal control design for nonlinear reactor systems using Lyapunov functionals is introduced. (Disser. Abstr.)

25172 REACTOR AND FUEL-PROCESSING TECHNOLOGY. Volume 11, Number 1. Dutton, James J.; Lennox, David H.; Brown, Karl K.; Royal, Joseph; Gold, Raymond; Gregory, Paul H. (eds.). One of the Four Technical Progress Reviews Published for the Division of Technical Information, USAEC. Argonne, Ill., Argonne National Lab., Winter 1967–1968. 68p. GPO $0.70.

Technical progress is reviewed under the following topics: reactor safety, design and construction practice, operating experience, fuel and thermal technology, aqueous processing, nonaqueous processing, and waste disposal. Separate abstracts were prepared for eight of the nine sections. The remaining section contains highlights of the Aix Conference of Fast Reactor Safety. (M.C.G.)

For abstracts of individual sections see: 23777, 23106–23109, 24991, 24992, and 25145.

25173 NUCLEAR REACTOR FUEL ELEMENT ASSEMBLIES. Haslam, Robert James; Leaver, Bernard (to United Kingdom Atomic Energy Authority). U. S. Patent 3,344,036. Sept. 26, 1967. Priority date Sept. 29, 1964, Great Britain.

The description of a nuclear reactor fuel element assembly is presented. The assembly consists of a cluster of spaced elongated parallel sheathed rods supported at the end and separated by transverse bracing grids. Wear pads in the form of elongated projections parallel to fuel rods longitudinal axes connect the fuel rods with the bracing grids. (D.C.C.)

25174 FUEL ROD STRUCTURE. Nazzer, Don B.; Pawliw, John U. S. Patent 3,345,267. Oct. 3, 1967. Priority date Aug. 28, 1964, Canada.

The description of a nuclear reactor fuel element cluster is presented. The fuel element cluster consists of multiple parallel rods forming concentric rings. The fuel rods are separated by connecting nodules convexly faced and symmetrically located on each rod. (D.C.C.)

25175 NUCLEAR REACTOR FUEL ROD WITH CONTACTING WARTS. Howieson, J.; McGregor, J. C. Canadian Patent 780,546. Mar. 12, 1968.

The fuel assembly consists of a bundle of several thin-walled Zircaloy-2 tubes filled with UO_2 pellets. To minimize wear and breakdown of the individual fuel elements during assembly and when slight movement occurs in service, the outer surface of the cladding has convex "warts" with chamfered ends so that the contact area between adjacent elements is reduced to a minimum. These small projections also provide more clearance for coolant flow. These warts are brazed or welded to the Zircaloy-2 tube. Open plate spacers secure the fuel elements at each end of the bundle. (F.S.A.)

25176 RADIOISOTOPES PRODUCTION IN NUCLEAR REACTOR CONTROL RODS. Bodnarescu, M. V. (to Communaute Europeenne de l'Energie Atomique-EURATOM). Canadian Patent 779,417. Feb. 27, 1968. Priority date Oct. 18, 1963, Belgium.

Target material to be irradiated is placed in the interior of a control rod which absorbs the thermal neutrons. Epithermal and fast neutrons, however, reach the target material. In another embodiment, a capsule contains filter material so that only neutrons of energies liable to affect the target material reaches the interior. (F.S.A.)

25177 IMPROVEMENTS RELATING TO GRAPHITE STRUCTURES IN NUCLEAR REACTORS. Netley, Peter Thomas; Kelly, Brian Thomas (to United Kingdom Atomic Energy Authority). British Patent 1,106,432. Mar. 20, 1968. Filed Apr. 2, 1965.

The description of a moulded graphite lattice structure for nuclear fuel elements is presented. The graphite has an isotropy ratio with respect to thermal expansion of not more than 1.2, and a thermal expansion coefficient greater than 4.5×10^{-6} per °C. (D.C.C.)

25178 IMPROVEMENTS IN OR RELATING TO HEAT EXCHANGERS. Charcharos, Anthreas Nicholas; Taylor, Peter Anthony (to Babcock and Wilcox Ltd.). British Patent 1,109,395. Apr. 10, 1968. Filed Aug. 25, 1965.

The description of a heat exchange with two banks of tubes is presented. A heating fluid passes through the first bank of tubes, and the second bank of tubes carries fluid to be heated. An intermediate heat exchanging fluid in a closed-path serves to transfer heat from one tube bank to the other. The closed-path heat exchanger fluid has baffled flow control. (D.C.C.)

25179 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS. Hawkins, Ronald James (to Babcock and Wilcox Ltd.). British Patent 1,107,916. Mar. 27, 1968. Filed July 6, 1965.

The description of an integral nucleon reactor is presented. The reactor consists of a cylindrical pressure vessel which contains the fuel element assembly and overhead heat exchangers. The heat exchange tube banks are surrounded by a casing which forms an annular space with the pressure vessel. Multiple pumps serve to move coolant between the casing wall and pressure vessel. (D.C.C.)

25180 NUCLEAR REACTOR FUEL ELEMENT ASSEMBLIES. Sinclair, William Norman; Waite, Edward (to United Kingdom Atomic Energy Authority). British Patent 1,108,020. Mar. 27, 1968. Filed Oct. 30, 1964.

The description of a nuclear reactor fuel assembly consisting of two sub-assemblies connected end-to-end is presented. The sub-assemblies are attached by a releasable coupling of two inter-engaging members and a locking member. The inter-engaging members consist of a shaft and a sleeve having inter-engaging splines arranged to allow longitudinal axial movement and not angular movement. The locking member comprises a splined locking collar which slides on inter-engaging splines on the shaft. The splines of the collar are angularly displaced from the splines of the sleeve. (D.C.C.)

25181 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTOR FUEL ELEMENTS. Franklin, Norman Laurence (to United Kingdom Atomic Energy Authority). British Patent 1,106,125. Mar. 13, 1968. Filed Oct. 30, 1963.

Means for reinforcing the fins of a fuel element against deformation from the forces exerted on them by a fluid coolant are described. The fins may be either helical, herringbone, or longitudinal. The fins are reinforced near their tips by welding spaced interconnecting members (strips or rods) to the fuel element sheath. The members are attached to each fin and are made of the same material as the sheath. (H.D.R.)

25182 IMPROVEMENTS RELATING TO NUCLEAR REACTOR CONTROL ELEMENT OPERATING MECHANISMS. Laycock, William; Stacey, John (to United Kingdom Atomic Energy Authority). British Patent 1,106,436. Mar. 20, 1968. Filed July 14, 1965.

The description of a two-part drive mechanism for a control element is presented. One part of the mechanism consists of a lift-lower device and an electromagnet for supporting the second portion. The second portion of the mechanism consists of an armature for engaging the electromagnet and a douple mechanical couple for releasing the control element. The mechanical couples are releasable by twisting in opposite directions. (D.C.C.)

25183 IMPROVEMENTS IN OR RELATING TO A PROCESS FOR THE PRODUCTION OF CANNED FUEL ELEMENTS FOR NUCLEAR REACTORS AND APPARATUS FOR PERFORMING SUCH PROCESS. Feutrel, Claude; Fuhrmann, Robert; Hodasava, Pierre (to Commissariat a l'Energie Atomique). British Patent 1,106,047. Mar. 13, 1968. Priority date July 9, 1964, France.

The description of an apparatus for supporting a nuclear fuel element during its canning operation is presented. The apparatus supports the element vertically as the element sits on a form-fitting bottom support. The operation is performed at high hydrostatic pressure in hot or cold state. (D.C.C.)

25184 FUEL ASSEMBLY FOR NUCLEAR REACTOR. Defreyn, Bruno; Ladagnous, Jean-Paul; Plessy, Serge (to Commissariat a l'Energie Atomique). British Patent 1,108,148. Apr. 3, 1968. Priority date Mar. 3, 1966, France.

The description of locking mechanism to stabilize fuel elements in a liquid-cooled nuclear reactor is presented. The locking mechanism consists of a ring of balls which are forced by coolant flow into recesses in the fuel element. The locking mechanism is held in an unlocked position by a spring when no coolant flow pressure is present. The system is designed for ascending coolant flow. (D.C.C.)

25185 IMPROVEMENTS RELATING TO THE DETECTION OF FUEL ELEMENT SHEATHING FAILURES IN NUCLEAR REACTORS. McKnight, James Alan; Webb, John; Collinson, Alfred Edward; Gatley, John Andrew; Boorman, Colin; McFall, Albert (to United Kingdom Atomic Energy Authority). British Patent 1,108,137. Apr. 3, 1968. Filed Aug. 21, 1964.

A detection mechanism for fuel element cladding failure in a liquid-cooled reactor is described. The mechanism consists of a skirt and rotating vane assembly to provide a vortex motion in the coolant flow. If a fuel element clad fails gas bubbles are present in the coolant flow and are directed by the vortex motion to the axis of rotation. The center collection zone of the skirt acts as a brake on the rotation of the skirt and is hydraulically coupled. The gas accumulation causes release of the brake and therefore faster rotation of the skirt. Centrifugal weights carried by the skirt swing out at the higher skirt speed and strike an alarm bell. (D.C.C.)

25186 IMPROVEMENTS IN NUCLEAR REACTOR COOLANT FLOW REGULATORS. Gatley, John Andrew; Esson, George (to United Kingdom Atomic Energy Authority). British Patent 1,108,817. Apr. 3, 1968. Filed July 14, 1965.

The description of a nuclear reactor coolant flow regulator is presented. The flow regulator consists of an elongated passageway between two concentric cylindrical sleeves. A partition is movable in the passageway to vary the length of flow clearance without affecting the flow cross section. (D.C.C.)

25187 IMPROVEMENTS RELATING TO NUCLEAR REACTORS. Jackson, George Oliver (to United Kingdom Atomic Energy Authority). British Patent 1,106,256. Mar. 13, 1968. Filed June 15, 1965.

The description of a nuclear reactor core configuration of multiple fuel elements is presented. The core consists of groups of

fuel elements. In each group there is one centrally located control element surrounded by fuel elements tilted toward the center. Some of the fuel groups contain central fuel elements instead of control elements. The fuel elements are supported at one end in a cantileve fashion to bearing surfaces connected to bearing surfaces. The tilting of the fuel elements is produced by misalignment of one of the bearing surfaces. (D.C.C.)

25188 NUCLEAR REACTOR CORES. Greenhalgh, Frank Geoffrey; Bradley, Norman (to United Kingdom Atomic Energy Authority). British Patent 1,105,783. Mar. 13, 1968. Filed June 9, 1965.

The description of a reactor core of multiple calandria tubes arranged on a square lattice pitch is presented. The liquid-moderator core has symmetric inner walls of vertical corrugations extending across the width to support varying hydraulic heads. (D.C.C.)

25189 FUEL ASSEMBLY FOR A NEUTRONIC REACTOR. Keller, Herbert W.; Andrews, Harry N. (to Westinghouse Electric Corp.). U. S. Patent 3,368,945. June 21, 1963.

A description of an internally supported fuel element assembly is given; the support members are arranged to compensate for thermally induced deformation. The assembly consists of at least two bundles of rods placed in tandem with the casing. The elongated structure of the assembly may contain a blanket portion of fuel elements, also. (M.L.S.)

25190 FUEL ASSEMBLY. Jenssen, Sverre K. (to Alfa-Laval AB). U. S. Patent 3,368,946. Feb. 25, 1965. Priority date Mar. 4, 1964, Sweden.

A fuel assembly having increased heat transfer characteristics is described. The fuel elements are positioned cylindrically around a coolant channel. Coolant flow is effected in both longitudinal and transverse directions; the coolant is allowed to leave the fuel assembly at any point along its length. (M.L.S.)

25191 METHOD AND DEVICE FOR THE SUPERVISION OF AN ELECTRICAL CONTROL SYSTEM, ESPECIALLY OF A SAFETY SWITCHING SYSTEM OF A NUCLEAR REACTOR. (to Gesellschaft fuer Kernforschung, mbH). British Patent 1,108,258. Apr. 3, 1968. Priority date Dec. 31, 1964, Germany.

A method and device for monitoring an electrical control system is described. This method and device is particularly applicable to reactor safety systems. Input test signals are compared to output test signals; discrepancies trigger correction operations. The monitoring instrument consists of a transmitter, receiver, and controller. (M.L.S.)

25192 MODERATOR CALANDRIA TANK FOR PRESSURE TUBE REACTOR. Rigal, Jean (to Commissariat a l'Energie Atomique). British Patent 1,109,826. Apr. 18, 1968. Priority date Apr. 6, 1966, France.

A description of a moderator tank for horizontal pressure tube type reactors is given. The tank has a rigid horizontal top wall, deformable ovate side walls, and a directrix which corresponds to the hydrostatic distribution of the moderator pressure inside the tank; the two end walls are traversed by the pressure tubes. (M.L.S.)

25193 IMPROVEMENTS IN OR RELATING TO PRE-STRESSED CONCRETE PRESSURE VESSELS. Sage, Frederick (to United Kingdom Atomic Energy Authority). British Patent 1,106,078. Mar. 13, 1968. Filed June 17, 1964.

A cylindrical concrete reactor pressure vessel is described in which the slabs forming the vessel ends are braced against internal pressure by cables under tension. The cables are disposed symmetrically around the longitudinal axis of the vessel, and means is provided to protect the cables from the elevated temperatures in the core. The cables are capable of continuous and automatic compensation for thermal expansion. (H.D.R.)

25194 NUCLEAR FUEL ELEMENTS. (to United States Atomic Energy Commission). British Patent 1,110,657. Apr. 24, 1968. Priority date July 20, 1965, United States.

The description of a ceramic fuel element is presented. The fuel element consists of a stack of annular sintered pellets in the center surrounded by a helical wire and a mass of granular fuel. The pellets and granular fuel are relatively low in fissionable material content. The helical wire is very high in fissionable material content. The helical wire varies continuously in pitch from a maximum at mid region in the length of the wire to a minimum at the ends of the wire. (D.C.C.)

25195 BEAM PORT CLOSURE FOR NUCLEAR REACTOR. Sperry III, E. D. (to United States Atomic Energy Commission). U. S. Patent 3,384,751. May 21, 1968.

A beam port closure for a high energy neutron beam from a nuclear reactor is described. A ball having an aperture corresponding to the beam cross-sectional size and shape and having helical grooves is keyed to movable shutters by tabs that slidably move in the grooves to engage the shutters and the ball to open and close the shutters respectively when the ball is selectively turned to transmit or block the beam. (AEC)

25196 CORE ELEMENT HANDLING SYSTEM. Paget, John A. (to United States Atomic Energy Commission). U. S. Patent 3,383,286. May 14, 1968.

A system for handling a plurality of removable core elements for a nuclear reactor is described. A sleeve penetrates the core and contains a lifting assembly with a telescopable section having inner and outer coaxial tubes coupled with a pneumatic device to move the tubes. (AEC)

25197 NUCLEAR REACTOR FUEL CHANNEL ASSEMBLY. Drummond, Carl N. (to United States Atomic Energy Commission). U. S. Patent 3,379,614. Apr. 23, 1968.

A fuel channel assembly for nuclear reactors comprising a closed moderator tank, a first nozzle forming an opening through the top of the tank, a second nozzle forming an opening through the bottom of the tank, and a fuel channel assembly extending through the tank for flowing primary coolant is described. The coolant remains out of contact with the moderator in the tank. A tubular member extending through the first nozzle, the moderator tank, and the second nozzle is integrally connected at its opposite ends to welded plates. The channel assembly is removable from the moderator tank by breaking the plates seal welds. (AEC)

25198 DEVICES FOR RESTRICTING FLUID FLOW. Emsley, George Michael; Robinson, John Albert (to Nuclear Power Plant Co., Ltd. AEI-John Thompson Nuclear Energy Co., Ltd.). British Patent 1,106,900. Mar. 20, 1968. Filed June 18, 1965.

The description of a cylindrical device for restricting fluid flow is presented. The device consists of a radially finned cylinder with tapering upper and lower ends. The cylinder is arranged to move freely but is designed to have fluid pressure maintain it against a seating device. The duct surrounding the cylinder is arranged to have a reduced diameter at the lower end compared to the diameter of the middle and upper end. (D.C.C.)

25199 PROCESS AND APPARATUS FOR MEASURING THE DOUBLING TIME OF A NUCLEAR REACTOR. Ferrari, Achille; Lacour, Jacques; Parroco, Robert; Polychronakis, Georges (to Commissariat a l'Energie Atomique). British Patent 1,106,320. Mar. 13, 1968. Priority date Oct. 8, 1965, France.

The description of an apparatus for measuring the doubling time of a nuclear reactor is presented. The apparatus consists of a cascade of binary counters, a bank of serially connected bistable multivibrators, the first of which receives, after shaping, the pulses delivered by detectors; a logic unit which is associated with the stages of the bistable cascade and which delivers a pulse at the first activation of each stage; an electronic clock; two parallel-operating counting units which count the clock reference pulses alternately with the pulses delivered by the logic units; and printing facilities. (D.C.C.)

25200 HYDRAULIC ACTUATOR FOR MOVING A ROD LONGITUDINALLY OF ITSELF. (to Babcock and Wilcox Co.). British Patent 1,106,830. Mar. 20, 1968. Priority date Jan. 24, 1966, United States.

The description of a hydraulic actuator for positioning a nuclear reactor control element is presented. The actuator consists of a cylinder, a piston reciprocable in the cylinder and having a rod extending axially through it, and a clutch, The clutch is designed to allow movement of the control rod in one direction and to prevent movement when the piston moves in the opposite direction. The clutch consists of a wedge carried by the piston and a ring of balls surrounding the rod. When the piston moves in a reversing motion the wedge engages the balls and provides frictional retention of the rod. (D.C.C.)

25201 NEUTRON COLLIMATOR WITH VARIABLE PASSAGE CROSS-SECTION. Krebs, Karlheinz; Rochez, Rene (to European Atomic Energy Community). British Patent 1,110,894. Apr. 24, 1968. Priority date Mar. 25, 1966, Germany.

The description of a neutron collimator for a nuclear reactor is presented. The collimator consists of two opposing blocks which are movable toward and away from each other. The blocks form a passage which tapers in the axial direction. The blocks are joined to the throughway with a sawtooth configuration. The throughway has interchangeable slots which are rotatable to vary the obliquity of the block surfaces. (D.C.C.)

25202 NUCLEAR REACTOR INSTALLATION. Cairns, Walter John; Healy, John Barry (to United Kingdom Atomic

Energy Authority). British Patent 1,110,788. Apr. 24, 1968. Filed Oct. 7, 1964.

The description of a liquid-moderated nuclear reactor core is presented. The core consists of pressure tubes in a lattice pitch and terminating in standpipes. The standpipes have radially extending flanges for maintaining position and for preventing deformation. The flanges of the standpipes in the lattice form a brace against each other. A refuelling machine nose adapter is located in the free end of each standpipe. (D.C.C.)

25203 (AAEC/TM-410) A SELECTIVE SURVEY OF LITERATURE ON WATER TUNNELS TO PROVIDE A BASIS FOR THE DESIGN OF THE LUCAS HEIGHTS WATER TUNNEL. Gleed, D. B.; Saiva, G. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Oct. 1967. 28p. Dep.

All types of water tunnels are discussed but particular emphasis is placed on the closed loop, closed jet tunnel design since this type gives maximum experimental flexibility. Individual tunnel components and ancillary equipment are discussed in detail. The bibliography gives references relating to tunnel design, performance and operation. (auth)

25204 (AERE-R-5602) USING CUBIC SPLINES TO APPROXIMATE FUNCTIONS OF ONE VARIABLE TO PRESCRIBED ACCURACY. Curtis, A. R.; Powell, M. J. D. (Atomic Energy Research Establishment, Harwell (England)). Nov. 1967. 38p. Dep. CFSTI. UK.

The intention of this paper is to present an algorithm to approximate a continuous function, f(x), over a given range, $a \leq x \leq b$, by a cubic spline, s(x), which deviates from f(x) by not more than a prescribed accuracy, ϵ. It is presumed that f(x) can be calculated for any x in the range, the approximation by a simpler function being required because each evaluation of f(x) is laborious; therefore it is attempted to use few function values in obtaining the representation. The strategy is to refine an initial crude approximation iteratively by inserting extra knots where indicated by an error estimate, so the problem of estimating the magnitude of the error function is fundamental. It is demonstrated that a useful solution may be obtained by means of difference operators. The effect of function value errors is discussed, and some numerical examples are presented. (auth)

25205 (CONF-670445) THE CHALLENGE OF THE 1970's. Fourth Space Congress, Cocoa Beach, Florida, April 3-6, 1967. (Canaveral Council of Technical Societies, Cocoa Beach, Fla.). 790p.

Papers are presented in 27 sessions on developments in materials, equipment, instruments, and scientific techniques with promising potential applications in the near future. Separate abstracts were prepared for 3 papers from session 18 on Propulsion and Power Systems. (H.D.R.)

For abstracts of individual papers see: 23217, 25059, and 25060.

25206 (COO-1301-5) PROGRESS REPORT [ON GENETICS] DECEMBER 1, 1966-DECEMBER 1, 1967. Ellingboe, Albert H. (Michigan State Univ., East Lansing). Feb. 1968. Contract AT(11-1)-1301. 4p. Dep. CFSTI.

A search was begun for genetic markers that could be used as selective means for detecting recombinational events in Schizophyllum commune and Coprinus lagopus. Mutations from auxotrophy to prototrophy were induced with chemical mutagens. Protein extracts of mycelia showed no differences in the zymograms between the various matings. There were also no differences for catalase, peroxidase, and alkaline phosphatase. Studies were conducted to determine the kinetics of nuclear exchange in matings. Experiments were also begun on evidence for cytoplasmic interaction in matings, and a technique was developed for isolating ribosomes from mycelia of Schizophyllum. (H.L.W.)

25207 (COO-1352-28) THERMAL CONDUCTIVITY OF POTASSIUM VAPOR. Briggs, Dale E. (Michigan Univ., Ann Arbor. Dept. of Chemical and Metallurgical Engineering). Feb. 1968. Contract AT(11-1)-1352. 220p. Dep. CFSTI.

Thesis.

The purpose of this investigation was to design, construct and operate a high-temperature cell for measuring the thermal conductivity of potassium vapor within the temperature range of 900 to 1400°F. A thorough review of all the techniques used to measure thermal conductivity of gases and vapors was made with particular attention to those methods suitable for high temperatures and corrosive vapors. A parallel plate cell with guard-heated top plate was selected. Heat generated in the 2.01-inch-diameter top plate by the top plate heater was transferred across a 0.0182-inch vapor space to the bottom plate. Molybdenum was selected for the cell material because of its corrosion resistance to potassium, low emissivity and high thermal conductivity. The thermal conductivity of nitrogen was measured with the cell to serve as a check on the cell and analysis procedure. The thermal conductivity of nitrogen thus measured for a temperature range of 900 to 1200°F was in excellent agreement (within 1%) with existing data. Thermal conductivity data for superheated potassium vapor were taken at temperatures of 1000, 1100, and 1200°F and a range of pressures of 0.01 to 0.075 atmospheres. The pressure of the potassium vapor in the cell was kept below the saturation pressure by maintaining liquid potassium in a boiler connected to the thermal conductivity cell at a temperature 100 to 400°F below the cell temperature. As predicted by theory the data show that pressure has a significant effect on the thermal conductivity. Combining theory with experimental results, the increase in thermal conductivity over that for an equivalent nonreacting system at 1100°F was found to be 7 and 42%, for pressures of 0.01 and 0.075 atmospheres, respectively. The increase is caused by the heat of reaction associated with shifts in the equilibrium composition with changes in temperature and pressure. Potassium exists in the vapor as a monomer, dimer, and tetramer. The thermal conductivity of potassium for an equivalent nonreacting system at 1100°F was calculated to be 0.0074 Btu/hr-ft-°F as compared to measured values of 0.0079, 0.0088, and 0.0105 Btu/hr-ft-°F at pressures of 0.01, 0.03, and 0.075 atmospheres, respectively. Kinetic theory was used as a basis for placing correlating curves through the data. The mean values of the thermal conductivity of potassium are estimated to be accurate to within ±10%. These results agree closely with a limited amount of data taken with a different type cell reported in the literature. (auth)

25208 (COO-1446-2) THE ROLE OF POPULATION: DEPENDENT FACTORS IN ALTERING ADRENAL STEROIDOGENESIS AND REPRODUCTION IN THE COTTONTAIL RABBIT IN OHIO. Final Report. Stevens, Vernon C. (Ohio State Univ., Research Foundation, Columbus). Mar. 1968. Contract AT-(11-1)-1446. 13p. Dep. CFSTI.

ADRENAL GLANDS—secretion of steroids by, of rabbits in Ohio, effects of physiographic regions on

RABBITS—secretion of adrenal steroids by, effects of population-dependent factors on

25209 (COO-1712-1) FUNDAMENTAL STUDIES OF CONCENTRATED ELECTROLYTE SOLUTIONS. Technical Progress Report. Leifer, Leslie (Michigan Technological Univ., Houghton. Dept. of Chemistry and Chemical Engineering). Feb. 29, 1968. Contract AT(11-1)-1712. 15p. Dep. CFSTI.

Progress is reported on: Hammett acidity measurements in mixed acid-salt media, electrolyte behavior in concentrated solutions, thermodynamic properties of concentrated $HClO_4$, HCl-catalyzed ester hydrolysis, and HCl-catalyzed amide hydrolysis. (M.C.G.)

25210 (DP-1128) GENERALIZED LINEAR REGRESSION ANALYSIS. Knight, F. Delano (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). Feb. 1968. Contract AT(07-2)-1. 26p. Dep. CFSTI.

A generalized computer program developed to fit selected functions to experimental data by the method of least squares is described. This program is characterized by a wide selection of functional forms for the independent and dependent variables, an extensive listing of descriptive statistics, and a simple input form that facilitates program use. (auth)

25211 (DUN-2400) FORTRAN PROGRAMMING. Gross, P. D. (Douglas United Nuclear, Inc., Richland, Wash.). Jan. 1968. Contract AT(45-1)-1857. 160p. Dep. CFSTI.

The computer programming language FORTRAN IV is described. How data are stored and transferred within the basic elements of the computer is discussed. The structure and use of the various basic elements which make up the FORTRAN language itself are examined. Examples are included to demonstrate or clarify usage of these elements wherever necessary. Techniques in setting up an application for programming (flowcharting) and in debugging a program once it has been written are considered. (W.H.K.)

25212 (K-DP-3109) GENOUT: A GENERALIZED OUTPUT PROGRAM FOR NUCLEAR SCIENCE REFERENCE DATA. Owings, Jack H. (Oak Ridge Gaseous Diffusion Plant, Tenn.). Feb. 26, 1968. Contract W-7405-eng-26. 47p. Dep. CFSTI.

GENOUT is an IBM 7090 computer program which operates on the data base represented by the cataloging and indexing of Nuclear Science Abstracts. This program provides capability to select entries from these data which meet specified bibliographic criteria and output them in a variety of formats. Citations, subject headings and modifiers, and keywords can be listed to comprise a microabstract. These can be sorted, after selection, on various fields as desired and listed with sequence numbers assigned. Then, the usual NSA indexes can be prepared to these sequence numbers. (auth)

25213 (LA-3878) BROACH FOR SHEARING ROTATING BANDS FROM RIFLE-BORE-FIRED PROJECTILES. Barbo, Paul E.; Cercy, James C.; Gillespie, Ben J. (Los Alamos Scientific Lab., N. Mex.). Feb. 6, 1968. Contract W-7405-eng-36. 5p. Dep. CFSTI.

A broach for cutting off the protruding portion of the rotating band on an artillery shell as the shell leaves the gun muzzle is being developed by Group W-3 at Los Alamos Scientific Laboratory. The purpose of the band broach is to decrease the frontal area of the shell, and, thereby, decrease the drag during flight. The percentage of increase in maximum range equals about seven-tenths of the percentage of decrease in frontal area. (auth)

25214 (LA-DC-9245) CHAIN BRANCHING AND INITIATION RATES MEASURED BY SPATIALLY INTEGRATED LIGHT EMISSION DURING REFLECTED SHOCK WAVE IGNITION. Schott, Garry L. (Los Alamos Scientific Lab., N. Mex.). [1968]. Contract W-7405-eng-36. 22p. (CONF-680701-1). Dep. CFSTI.

For Presentation at the 12th Symposium on Combustion, Poitiers, France.

Experimental study of ignition kinetics in $H_2-O_2-CO-Ar$ mixtures by time-resolved photoelectric measurement of the growth of spatially integrated CO-O recombination radiation in reflected shock waves was extended to cover the ranges $0.1 \leq H_2:O_2 \leq 10.0$ and $1000 \leq T \leq 2500°K$ by confining the reactive gas to the downstream end of the shock tube and increasing sensitivity through a large solid angle optical view. The induction period regime of exponential growth of emission intensity, $I(t) \approx I_0^* \exp(\alpha^* t)$, yielded precise values of α^* whose dependence on $[H_2]$, $[O_2]$, and T determines, for the reactions $H + O_2 \xrightarrow{k_1} OH + O$, $O + H_2 \xrightarrow{k_2} OH + H$, and $OH + H_2 \xrightarrow{k_3} H_2O + H$, the functions: $k_1 = 8.6 \times 10^8 \exp\{-(12.3 \pm 1)$ kcal/mole $(1/T - 1/1600)/R\}$ liter/mole/sec and $k_2k_3 = 1.5 \times 10^{19} \exp\{-(20 \pm 4)$ kcal/mole $(1/T - 1/1600)/R\}$ liter^2/mole^2/sec^2, and indicates that k_2 and k_3 are at most about a factor of 3 from each other in the present temperature range. The early growth of I(t) prior to the exponential regime, now observed directly, and the parameter I_0^*, now fairly precisely measured, bear on the kinetics of chain initiation but require further investigation. (auth)

25215 (LF-38, pp 113-17) ISOLATION AND CHARACTERIZATION OF URINARY CORTICOSTEROIDS IN NORMAL BEAGLE DOGS. (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.).

Urine from normal beagle dogs was extracted before and after glucuronidase hydrolysis. The isolated material was chromatographed on column and paper and separated into individual fractions. Five fractions were isolated and subjected to chemical tests and mobility evaluation in paper chromatographic systems. One fraction was tentatively identified as tetrahydrocortisol. Four other substances exhibited chemical reactions and mobilities in paper chromatographic systems similar to cortisol, tetrahydrocortisone, tetrahydrocorticosterone, and 6 β-hydroxycortisol. (auth)

25216 (LF-38, pp 118-22) URINARY EXCRETION OF STEROIDS BY BEAGLE DOGS FOLLOWING ADMINISTRATION OF ADRENOCORTICOTROPHIC HORMONE. (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.).

The mean urinary excretion of 17-ketosteroids, 17-ketogenic steroids, and 17-hydroxycorticosteroids in 11 normal beagle dogs was 0.16 ± 0.09 mg per 24 hours, 0.87 ± 0.23 mg per 24 hours, and 0.06 ± 0.03 mg per 24 hours, respectively. Intramuscular administration of corticotrophin (ACTH) caused an increase in the urinary excretion of these steroids. Normal dogs excreted 33% free urinary corticosteroids, and following ACTH, the level remained about the same. (auth)

25217 (LF-38, pp 123-6) ANTIGENIC STUDIES OF BEAGLE CELL CULTURE. (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.).

A comparison of the antigenicity of uncultured, primary, tertiary, and continuous-line cells of beagle dogs to that of human-cell cultures was made. The mixed hemagglutination (hemadsorption), the direct agglutination of dog and human erythrocytes, and the indirect fluorescent antibody methods were used. It appeared that species specific antigens were less in evidence as the number of cell passages increased in the continuous-cell lines, a common antigen was present in those of both dog and human tissues. (auth)

25218 (LF-38, pp 127-35) USE OF NUMERICAL METHODS FOR CLASSIFICATION, IDENTIFICATION AND FLORA STUDIES OF BACTERIA. (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.).

A general method for data reduction and its use for identification schemes has been developed. The method is applicable to all characteristics that can be recorded in a two-state basis—present (+ or 1) or absent (– or 0). Variables may also be used. The method was applied to constructing identification schemes for bacteria and in bacterial-flora studies. The importance of classification to identification is discussed. (auth)

25219 (LF-38, pp 136-8) CLINICAL STATUS OF BEAGLE COLONY. (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.).

The beagle dog colony utilized in the fission product inhalation program totaled 937 on September 30, 1967, with 227 of the animals assigned to life-span studies. Annual physical and special examinations were performed both pre- and post-exposure on dogs being used experimentally and in the breeding colony. Sixty-three of 430 dogs examined pre-exposure were considered significantly abnormal to preclude their use for longevity studies. There were two post-exposure animals with abnormalities in their electroencephalograph rerecordings and two with abnormalities in their electrocardiograms. No outstanding colony-wide clinical problems were encountered. Control of internal parasites in the breeding colony continued to represent the largest segment of therapy. (auth)

25220 (ORNL-TM-1923) EVALUATION OF LONG TUBES FOR EVAPORATORS. Final Report. Mitchell, B. E.; Smith, J. A. (Oak Ridge National Lab., Tenn.). Mar. 1968. Contract W-7405-eng-26. 79p. Dep. CFSTI.

The concept of utilizing long (to 360-ft) condenser tubes to achieve economies of construction and operation in large multistage flash evaporators was investigated. Tests where long tubes were installed under simulated field conditions have shown that long tubes can be successfully inserted with annular clearances between the tubes and the tube sheets as low as 0.0015 in. and that long tubes can be successfully installed by a combination of power feeding and automatic alignment of the tube with the tube sheet hole. An economic analysis indicated a 3% reduction in plant capital costs if long tubes are used in large MSF plants (250 Mgd). The savings in water cost over plants with 60-ft tubes are about 0.2¢/1000 gallons. The studies and tests indicated that the use of long tubes is feasible and that such designs should be considered for future large plants and modules. Long tubes appear to have a number of advantages for large plants which outweigh the disadvantages. The advantages include the following: a cost advantage of 3% reduction in capital cost and 0.2¢/1000-gallon reduction in water cost; energy losses in the intermediate water boxes are avoided; and there are fewer and shorter outages for leakage. The advantages of shorter tube bundles include the following: they are existing practice; less surface is lost when a leaking tube is plugged; thermal expansion problems are less severe; and the plant is better protected against major losses in the event of multiple tube failure in one or more adjacent stages. (auth)

25221 (ORO-3681-13) THE MODE OF NATURAL SELECTION AND BALANCED POLYMORPHISMS OF ENZYMATIC SYSTEMS IN DROSOPHILA SPECIES. Progress Report, May 1967–March 1968. Kojima, Ken-ichi (Texas Univ., Austin, Dept. of Zoology). Contract AT(40-1)-3681. 5p. Dep. CFSTI.

ENZYMES—analysis of polymorphisms of, in Drosophila ananassae and D. nasuta
INSECTA—Drosophila sp., determination of mutation rates of enzymes in
CHROMOSOMES—rearrangements in Drosophila sp., use of, to determine mechanisms for enzyme inversion polymorphisms

25222 (RLO-1377-6) RESPONSE OF RAT THORACIC DUCT LYMPHOCYTES CULTURED ON MOUSE MONOLAYERS. Tyler, Ruth W.; Ginsburg, Haim; Everett, N. B. (Washington Univ., Seattle, Dept. of Biological Structure). Nov. 1967. Contract AT(45-1)-1377. 11p. (CONF-671125-1). Dep. CFSTI.

From 3rd Annual Conference on Leucocyte Culture, Iowa City, Iowa.

Rat thoracic duct lymphocytes were cultured on monolayers of mouse embryos and the plates were observed daily to follow changes in the lymphoid cells and the monolayer. Plates were sacrificed daily and the morphology of the lymphocytes was examined. After 24 hr of incubation only small lymphocytes remained, large blast-like cells arose from these small lymphocytes on the second day of culture, and clones of large blast-like cells that apparently originated from a single cell were observed after three or four days of culture. Evidence of monolayer destruction appeared at the edge of these lymphocytic clones after four to six days of culture. When the large lymphoid cells were transferred to new plates the same type of monolayer destruction occurred within 16 to 24 hr. Transfer of large lymphoid cells to unrelated monolayers and transfer of cell-free culture fluid resulted in no destruction of monolayers. It was concluded that a cell-associated, rather than a humoral antibody present in the lymphocytes, caused destruction of the monolayer. The experiments were repeated

using tritium-labeled lymphocytes to obtain additional information on the type and kinetics of the lymphoid cells that were responsible for monolayer destruction. (C.H.)

25223 (SC-CR-67-2863) PACKAGING THREE-DIMENSIONAL OBJECTS USING GRADIENT TECHNIQUES. Bisson, C. L. (Thomas Bede Foundation, Los Altos, Calif.). Dec. 1967. Contract 72-3058. 74p. Dep. CFSTI.

For Sandia Corp., Albuquerque, N. Mex.

A technique is presented for placement of three dimensional objects within a surface of revolution and at the same time optimizing the following properties: 1. The objects shall fit as closely as possible. 2. Locate the center of gravity of the objects as close as possible to a specified point. 3. Minimize the error in dynamic and static balance. 4. Allow objects to be maintained at least a certain minimum distance apart. 5. Allow any of three degrees of translation or rotation to be fixed. The above are achieved by enclosing each object with one or several spheres and defining potential functions between the spheres. The potential functions and the above functions are optimized using gradient techniques. An example with ten objects is presented. (auth)

25224 (TID-24346) DEAERATOR EJECTORS AND BLOWERS FOR 50 MGD AND LARGER DESALINATION PLANTS. Research and Development Progress Report No. 311. Hammond, R. P. (Oak Ridge National Lab., Tenn.); Hunter, J. A.; Sieder, Everett N.; Tomalin, Paul G. (Office of Saline Water, Washington, D. C.). Nov. 1967. 59p. Dep. GPO $0.40.

In the design and the operation of seawater evaporators, care must be taken to prevent accumulations of noncondensable gases that can blanket condenser surfaces, interfere with efficient heat transfer, and cause corrosion of the evaporator internals. In a 50-Mgd flash evaporator plant which uses acid feed treatment, means must be provided for removing between 108,000 and 263,000 lb/day of gases which contain about 60% water vapor. A plant with atmospheric decarbonation will be near the low end of this range. Flow sheets are presented for a number of systems containing blowers, ejectors, surface condensers, barometric condensers, and decarbonation ponds. Detailed design calculations were made to determine the functional specifications for each of the components in each system. The evaluation of a large number of alternative materials led to the conclusion that the ejector and blower systems must be constructed of premium materials such as stainless steel, titanium, or Hastelloy C because of the highly corrosive environment. An addendum is included that reviews designs of noncondensable removal systems in fifteen 50-Mgd conceptual plant designs which indicates that the general design philosophy of removing noncondensables has not been standardized. It was concluded that equipment of the required size, and of materials with an expected life of thirty years in a desalination plant, is available only as special equipment. Experience with the fabrication of premium materials required for this service is not readily available. The economic evaluations, based on equipment which can be purchased now, have led to the following conclusions: a two-stage blower system with barometric condensers is the most economical centralized station arrangement for 50-Mgd plants; the optimum number of stages for blowers is two because the capital cost for additional stages rises faster than the savings in energy; the optimum number of stages for ejectors is three, since the steam consumption is considerably less than in a two stage ejector, while only a small additional efficiency is introduced in a four-stage ejector; a precondenser should be used to reduce the amount of water vapor to be evacuated; barometric precondensers and inter-condensers are preferred to surface condensers because of lower capital cost, less severe service for materials, less use of cooling water, and significant reductions in pumping power because of lower pressure drop; a cascade type (high head loss) decarbonating pond proved to be uneconomical; premium materials are required; and the economic evaluations should be reviewed for applications with substantially different ground rules or energy costs or if more efficient ejectors become available. (auth)

25225 (UCB-34-P-113-2) RADIOTRACER STUDIES ON THE MECHANISM OF INSECTICIDAL TOXICITY. Annual Progress Report, January 16, 1967–January 15, 1968. Casida, John E. (California Univ., Berkeley). Jan. 15, 1968. Contract AT(11-1)-34. 35p. Dep. CFSTI.

INSECTICIDES—metabolism in house flies and mice, tracer studies of
TOXICITY—reaction mechanisms for, of insecticides in house flies and mice
INSECTA—Musca domestica, resistance to insecticides, genetic analysis of
PHOSPHORYLATION—reaction mechanisms of uncouplers of oxidative, in house flies and mice
CARBON-14—labeling of insecticides, methods for (B.S.L.)

25226 (UCRL-17957) ROTATING DISK SYSTEM FOR THE STUDY OF METAL DEPOSITION FROM NONAQUEOUS SOLVENTS. Baucke, Friedrich G. K.; Landolt, Dieter; Tobias, Charles W. (California Univ., Berkeley. Lawrence Radiation Lab.). Dec. 1967. Contract W-7405-eng-48. 32p. Dep. CFSTI.

A rotating disk electrode system was designed to be used in metal deposition studies from nonaqueous solvents under inert atmosphere. The apparatus consists of a rigidly mounted drive unit and a detachable cell unit, which allows filling of the cell in a dry box while electrochemical measurements are made outside the box. Purification procedures for propylene carbonate and experiments on the deposition of potassium and calcium from propylene carbonate solutions are reported. (auth)

25227 (UCRL-50357) COMPLEX SHEAR MODULUS OF A HIGH EXPLOSIVE. Hamstad, Marvin A. (California Univ., Livermore. Lawrence Radiation Lab.). Oct. 24, 1967. Contract W-7405-eng-48. 22p. Dep. CFSTI.

A machine was designed to subject a right circular, cylindrical, viscoelastic specimen to forced, sinusoidal, torsional oscillation. The ends of the specimen are bonded to rigid boundaries, one of which is fixed, while the other is subjected to a sinusoidal torque. Measurement of the amplitude ratio of essentially the torque to the twist and the phase angle between these two quantities allows determination of the complex shear modulus of an assumed isotropic, homogeneous, linear, viscoelastic material. The complex shear modulus is obtained over a wide range of frequency (0.0004 to 1.0 cps) and temperature (–15 to 125°F) as well as at different levels of shear strain. The material tested is a high explosive known as LX-04-1. Assuming this material behaves as a thermorheologically simple solid, use of the time-temperature shifting principle allowed an extension of the time scale to 13 decades. This assumption also allows construction of the so-called master (or composite) curves for the storage and loss moduli. (auth)

25228 (UCRL-70638) DEDICATED COMPUTERS FOR INSTRUMENT CONTROL. Anderson, Roger E. (California Univ., Livermore. Lawrence Radiation Lab.). Mar. 15, 1968. Contract W-7405-eng-48. 14p. (CONF-671130-1). Dep. CFSTI.

From Conference on Digital Equipment Computer Use, Maynard, Mass.

The low-cost control computer can be readily interfaced to laboratory instruments by using breadboard circuitry. This paper describes several such applications using the PDP-8/S. Emphasis includes software techniques, system capability and versatility, and experimenter interaction. These systems are discussed as an alternate to a larger time-shared system. Specific examples are used to illustrate this philosophy. (auth)

25229 (UR-49-919) SOME ENVIRONMENTAL FACTORS INFLUENCING THE IN VITRO PHAGOCYTOSIS OF INERT TEST PARTICLES. Metzger, George V. (Rochester Univ., N. Y. Dept. of Radiation Biology and Biophysics). 1967. Contract W-7401-eng-49. 164p. Dep. CFSTI. Thesis.

The effects of a variety of environmental factors on the phagocytic activity of reticulo-endothelial cells from rat peritoneum or lungs were studied in vitro, using particles of metal oxides and carbon. Data are included on the effects of Ca or Mg and other multivalent cations added to the medium on the rate of phagocytosis. The effects of length of incubation, particle concentration, and cell concentration on phagocyte-particle systems in saline and glucose were also studied. (C.H.)

25230 (NP-tr-1625) RANDOM INSTABILITY OF NONLINEAR OSCILLATIONS. Zaslavskii, G. M. Translated for Culham Lab., Abingdon, Eng., from PMTF No. 2, 1967, pp 16-22. 15p. (CTO-426). Dep. JCL $1.60 fs, $0.80 mf.

A dynamic system is investigated whose behavior in time is described by $x'' + \omega_0^2 (1 + \alpha x^2)\, x + F(t)x = 0$ where an external force F(t) is very near periodical with frequency $\Omega \ll \omega_0$. Systems of this type, provided the non-linearity parameter α is sufficiently small, preserve a conditionally periodic motion. The solution can be represented in the form of a quasi-periodic motion with significantly varying phase. The determination of the criterion by which the dynamic system may be approximately described by statistical laws is combined with an explanation of the condition under which the time correlations of the phase decrease exponentially. It is necessary to show at what point in time the phase sequence in time may be considered approximately as a succession of random numbers. An asymptotic method is proposed for determining the randomness criterion for a motion of this type, and which is also applicable to slightly more complex systems. The proposed method cannot be described as mathematically exact. Certain regions, although from the physical point of view appear quite natural, may require some more exact justification. (W.H.K.)

25231 (SC-T-68-1504) CALCULATION OF LOADS DUE TO GUSTS. Kerisel, J. B. Translated by Marcel I. Weinreich

(Sandia Corp., Albuquerque, N. Mex.), from Proceedings of the 23rd Congress of AGARD in the Structure of Materials Section, Oct. 1966. 28p. Dep. CFSTI. JCL $2.60 fs, $1.10 mf.

The various aspects involved in the application of the technique of generalized harmonic analysis to gust loads on missiles in rough air are reviewed. The characteristics of the atmospheric turbulence velocity field are described. The technique for calculation of the responses (transient response especially) in rough air is presented with some applications to French missiles. (auth)

25232 ENERGIA JADROWA W POLSCE W LATACH 1961–1963. (Nuclear Energy in Poland in the Years 1961–1963). Hurwic, Jozef. Warsaw, Panstwowe Wydawnictwo Naukowe, 1966. 617p. (NP–17326).

A general progress report covering the whole field of nuclear energy in Poland during the years 1961–1963 is presented. Included are complete data related to the organizational questions as well as at the scientific achievements and technical applications for this period. (B.G.D.)